DECARBONISATION FUTURES

INDUSTRY

Can we decarbonise and grow by transforming the way we extract, make and supply goods?

ClimateWorks AUSTRALIA

There are a great many innovations available now and in development that can both help bring emissions down and grow Australia's industrial activity.

The science is clear that we must get to net zero emissions if we are to limit global temperature rise to well below 2 degrees and avoid the worst impacts of climate change. For developed countries like Australia, a 2 degree trajectory is generally accepted as requiring net zero emissions by 2050, while the pursuit of a 1.5 degree limit requires an earlier date, hence a more ambitious decarbonisation effort.

THE ROLE OF INNOVATION

A pathway to reaching net zero emissions requires reducing the emissions intensity of the economy at a rate of about 6 per cent per year on average – 1.6 times higher than the rate achieved from 2005 to now[1]. Innovative technologies and new ways of doing things will enable and strengthen the rapid shift towards transformative action that is required.

ClimateWorks Australia is analysing the abatement potential of a range of innovations in a new report, **Decarbonisation Futures**. This factsheet is based on initial insights gained through research and consultation undertaken during development of the full report. It provides an overview of the potential for innovations in industry - specifically, the mining, manufacturing and construction sectors - to accelerate our transition to net zero emissions. And it identifies the potential benefits from these innovations, along with the drivers of change that already are delivering, or could deliver these benefits.

A more detailed picture exploring the economy-wide potential of technology and innovation to change our decarbonisation trajectory will be presented in the full **Decarbonisation Futures** report.

THE ROLE OF INDUSTRY

The industrial sector covers a broad range of activities (including mining and manufacturing) and is the largest driver of Australia's emissions, with direct and indirect emissions (such as electricity) contributing nearly a third of all emissions in 2017[1].

The emissions intensity, the breadth of activities and the deep links between industry and other parts of the economy all give industry a critical role in achieving net zero emissions, yet the transition pathway for industry is recognised as being less well-defined than other sectors[2]. Recent analysis suggests that while this sector has the potential to reduce emissions by 30 per cent below 2005 levels by 2030, it is actually on track to increase by a further 6 per cent under current and proposed Australian policies[1].

Importantly, reducing industry emissions does not necessarily mean reducing industry output. There are a great many innovations available now and in development that can both help bring emissions down and grow Australia's industrial activity.

POTENTIAL IMPACT AT A GLANCE

Innovation in industry could change the game.

Here's just one example, with current and potential benefits:

3D PRINTING

(also known as '**ADDITIVE MANUFACTURING**') involves building up objects by depositing material one layer at a time.

It is already in use in major organisations including

NASA, Airbus and Boeing

- these organisations are realising the benefits of 3D printing not only through weight reduction, but also through the novel design solutions that become possible when paired with new composite and adhesive materials.

Even before including aerospace industry figures, investment in 3D printing sits at over US $7.3 billion[3]

3D PRINTING INDUSTRY = $7.3BN

And the growth rate for 3D printing investment is **NEARLY TRIPLE** that of traditional machines.

Some studies estimate that up to **half of manufacturing could be delivered through additive methods by 2060[4].**

Energy and emissions savings from the application of 3D printed parts are significant: For example, a 3D printed seatbelt buckle is 58% lighter than it's traditional counterpart.

THIS MEANS:

3D printing all **853 SEATBELT BUCKLES** on an Airbus A380 > would save **74KG PER PLANE**

Amounting to:

3,300,000

MILLION LITRES OF FUEL SAVED OVER THAT PLANE'S LIFETIME[5]

(or **0.74 $MtCO_2e$** avoided emissions)

RECENT KEY INNOVATIONS REDUCING EMISSIONS IN INDUSTRY

Industry comprises a wide range of activities and has a similarly diverse range of abatement opportunities. Throughout history the tools and processes used in industry have advanced significantly and innovations are central to this. The pursuit of continual improvement has seen the application of new technologies and innovative processes across the sector, leading to some continuous emissions reductions.

For example, industry has been benefiting from ever-increasing digitisation in mining and manufacturing processes. While technology-led innovations can deliver benefits for energy use and emissions in industry, improved business practices can also play a significant part in reducing emissions.

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TRENDS IN ENERGY EFFICIENCY

Industry in Australia has previously seen substantial energy and emissions intensity improvements through the application of a wide range of technology upgrades and operational improvements[6]. In particular, process control modifications - including the installation of automated control systems - have been widely implemented.

Technology retrofits and upgrades have also been common throughout industry, with installation of variable speed drives and waste heat recovery systems offering two prominent examples.

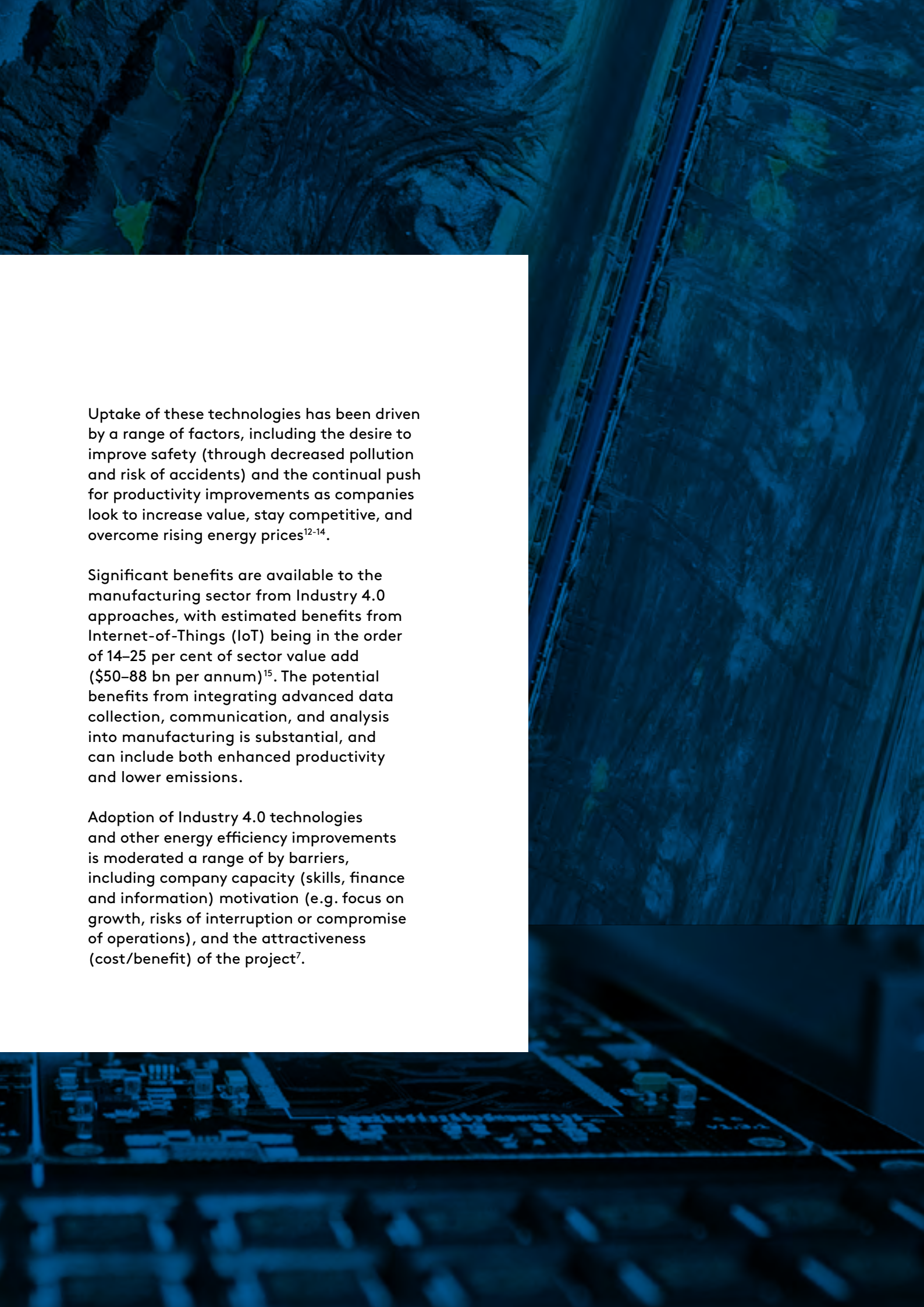
Uptake of these and other improvements has been driven by a number of factors, most significantly the need to maintain competitiveness in light of rising input costs. Other drivers include policy and regulation, consumer demand and social pressures for more sustainable production.

The level of energy savings achieved by a company is also influenced by internal company practices. Research has shown[7] that key factors supporting improvements to the energy efficiency performance of companies are: The regular analysis of energy data; inclusion of energy efficiency in corporate policies or operational guides; and board and senior management oversight of energy efficiency.

THE EMERGENCE OF INDUSTRY 4.0

Building on the electronics and automation brought into manufacturing in the latter part of the 20th century, we are now seeing the emergence of Industry 4.0 - the convergence of the physical and cyber worlds in a network of resources, information, objects and people[8]. A few key drivers enabling this trend[9] are: Rising data volumes, improving computational power and connectivity; emerging analytics and business-intelligence capabilities; new forms of human-machine interaction, such as touch interfaces, and augmented and virtual reality systems; and improvements in transferring digital instructions to the physical world.

Although Industry 4.0 is currently far from widespread, Australian industry is already beginning to utilise and capture the benefits of this approach. Australian mines have been at the forefront of automated technologies, where driverless trucks have been operating for over a decade, moving more than a billion tonnes of material during that time[10]. Other applications of advanced data management and analytics in mining include optimised underground ventilation, more accurate drilling and targeting of ore bodies, and improved communication between mining processes[11].



Uptake of these technologies has been driven by a range of factors, including the desire to improve safety (through decreased pollution and risk of accidents) and the continual push for productivity improvements as companies look to increase value, stay competitive, and overcome rising energy prices[12-14].

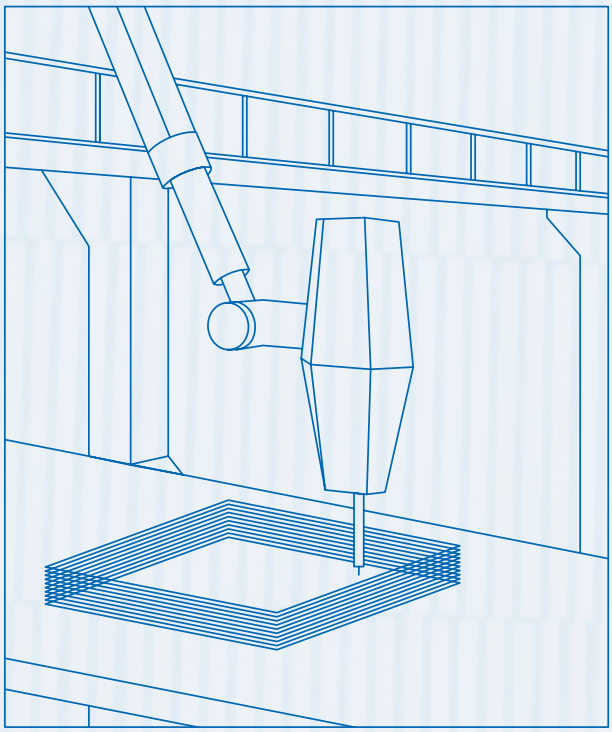
Significant benefits are available to the manufacturing sector from Industry 4.0 approaches, with estimated benefits from Internet-of-Things (IoT) being in the order of 14–25 per cent of sector value add ($50–88 bn per annum)[15]. The potential benefits from integrating advanced data collection, communication, and analysis into manufacturing is substantial, and can include both enhanced productivity and lower emissions.

Adoption of Industry 4.0 technologies and other energy efficiency improvements is moderated a range of by barriers, including company capacity (skills, finance and information) motivation (e.g. focus on growth, risks of interruption or compromise of operations), and the attractiveness (cost/benefit) of the project[7].

NEWER IDEAS TO MOVE INDUSTRY EMISSIONS TOWARDS NET ZERO

What might be next? The following examples, uncovered through our research and consultation with experts, illustrate how emerging innovations can further reduce emissions in industry.

3D PRINTING



3D printing (sometimes called 'additive manufacturing') involves building up objects by depositing material one layer at a time, using a computer controlled machine instructed by a digital model. This differs from traditional 'subtractive' manufacturing processes (such as turning and milling) which start with a block of material, and progressively remove material until the final form is reached. At present, 3D printing is viable mostly in niche, low-volume and high value applications in fields such as medical, aerospace, machinery, automotive and consumer products.

An Australian company, Titomic, is leading the world in large-scale metal 3D printing. Utilising world-exclusive technology co-developed with CSIRO, Titomic can now create super lightweight and very strong titanium parts more efficiently and cost effectively than is possible using traditional methods[16].

Potential energy savings from additive manufacturing have been estimated at between 5-27 per cent globally by 2050[17]. This would lead to significant emissions reductions and many other benefits, including reduced wastage, increased strength and complexity of products/assemblies, expedited development and speed to market, and improved energy efficiency of end-use products (eg. reduced fuel use due to lighter parts)[18,19].

Recent steep declines in equipment costs for 3D printing and increased availability of smaller and more user-friendly machines have spurred growth rates for investment in 3D printing to nearly triple that of traditional machines[4]. Drivers include cost reductions (across labour, transportation, inventory, waste etc.) and the potential competitive advantage offered by bringing manufacturing closer to sources of demand, enabling producers to be more responsive to consumer demand, delivering customised goods on demand. While 3D printing has the potential to redefine traditional manufacturing processes and supply chains, there are some trade-offs compared to the cost advantages of mass production, as well as technical or material limitations.

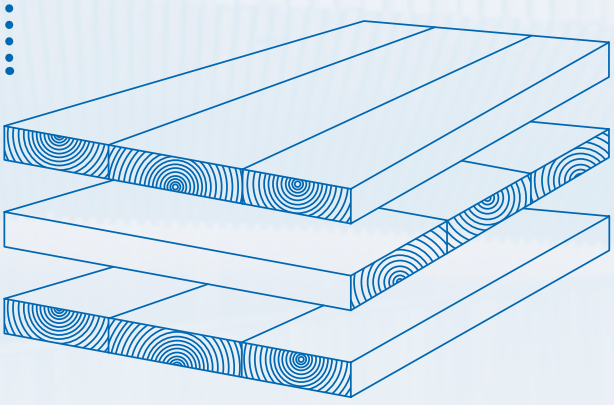
Additive manufacturing has the potential to deliver cascading improvements throughout supply chains and enable the development of new product offerings. This technology could have disruptive implications for manufacturing as it can affect how, when, and where products and parts are fabricated. The strategic implications of this process could therefore impact on whole commercial ecosystems[20], leading to unique risks and opportunities for industry.

MATERIAL SUBSTITUTION: TIMBER BUILDINGS

Building construction currently relies on materials produced in emissions intensive processes, such as steel and cement, which are not easily decarbonised. Materials substitution offers a solution to this problem by replacing carbon intensive materials with low-carbon and environmentally sustainable alternatives.

An example of materials substitution in the construction of buildings is the use of engineered wood products such as cross-laminated timber (CLT), rather than cement and steel in high-rise buildings. CLT uses boards of timber which are stacked and glued in a way that maximises strength. This approach has already been used for an apartment building in Melbourne - 'Forte Living' is a 10 storey building made from CLT and is currently the world tallest modern timber apartment building[21].

From an emissions perspective, timber products offer the dual benefit of both avoided emissions from reduced concrete and steel production, and the storage of carbon in the timber products themselves.



Additional benefits that engineered wood products such as CLT offer over conventional materials, include:

+ faster speed of installation, reduced construction costs (up to 10 per cent lower[22])
+ superior strength-to-weight ratio, building stability, thermal performance and fire resistance[23,24]
+ potential to use lower quality material from underutilised forest resources[25]

Although building with timber is commonplace in residential buildings, the use of CLT for other buildings can be inhibited by social factors such as consumer perceptions, lack of an established supply chain, the large volume of wood required for mass production and the absence of supporting building codes and policies[25]. Large-scale uptake of timber products could be fostered through increasing consumer understanding of the embedded emissions in traditional manufacturing and construction materials, demonstrating the benefits of using engineered wood products as more examples are built, and introducing strong policies and standards that support the use of timber in new developments.

There are many other potentially disruptive innovations in industry that would accelerate decarbonisation of the sector which we weren't able to cover here. Reducing emissions from the cement manufacturing process, and enhanced recovery and recycling of metals as part of a shift towards a more circular economy are both innovations we will assess and include in our full **Decarbonisation Futures** report.

There is already enormous potential to capitalise on existing opportunities that offer favourable benefit-cost ratios now, as well as through leveraging systems that make better use of existing technological innovations.

Industry forms part of a complex system, with many interactions between industrial sectors and the rest of the economy.

The depth and complexity of these interactions mean that a convergence and amplification of complimentary trends can all contribute to decarbonisation. However, this phenomena makes it nearly impossible to single out the individual potential of any one innovation, particularly those which are technology-led such as Industry 4.0, where potential cost reductions are likely to deliver a cascade of effects[26].

Importantly, while significant decarbonisation from the industry sector may be delivered by future breakthroughs in the application of technologies or transformative business models, we don't need to wait: There is already enormous potential to capitalise on existing opportunities that offer favourable benefit-cost ratios now, as well as through leveraging systems that make better use of existing technological innovations.

WHAT NOW?

There is an urgent need to better plan for, better develop and better enable these, and other innovations if we are to realise their potential. This requires complimentary actions from governments, businesses, investors and entrepreneurs.

Currently, despite the very real potential for major innovations to disrupt incumbent industries or create new markets, they are generally not incorporated into planning processes. This often means that risks as well as opportunities around disruption are not captured.

THERE ARE COMPELLING REASONS FOR URGENCY:

+ Emissions reductions in industry are not only currently off-track, emissions are actually projected to increase. The longer we wait, the more we must do later, or the greater the burden will be shifted onto other sectors. Further, the longer we take to act, the more we risk 'locking-in' future emissions right throughout supply chains and within society.

+ We cannot sit and wait for costs of decarbonised production processes to decrease, as we risk missing opportunities and becoming more vulnerable to disruption. Action can be taken now to move towards decarbonisation through supportive policy, reduced market distortions, encouraging demand (willingness to pay) and seeking technological breakthroughs.

+ The long life of industrial assets and the long time horizons involved in building or retrofitting industrial sites mean that investment and plans initiated now are better placed to efficiently achieve significant emission reductions, and to be ready to capitalise on future developments.

+ Innovation is not quick and easy. Great ideas can fail for a variety of reasons, and those that do succeed require long lead times to build up enabling finance, knowledge, market conditions, entrepreneurial culture and regulatory frameworks. Starting now with the decarbonisation of industry is therefore most likely to result in better outcomes for companies, as this will allow time for technological maturation and cost reductions, alongside advance planning for supporting transitions such as energy supply[2].

+ In a dynamic global market where other nations and states are striving for competitive advantage, the window of opportunity to incorporate innovations into production or to develop and launch innovations with worldwide potential may be small.

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This summary provides just a taste of the decarbonisation potential within emerging technologies across industry. A comprehensive, economy-wide analysis will be presented in ClimateWorks Australia's coming DECARBONISATION FUTURES report.

ABOUT US

ClimateWorks Australia is an expert, independent adviser, acting as a bridge between research and action to enable new approaches and solutions that accelerate the transition to net zero emissions for Australia and our region.

We were co-founded in 2009 by The Myer Foundation and Monash University and work within the Monash Sustainable Development Institute (MSDI), which convenes experts for a multi-disciplinary approach to the Sustainable Development Goals.

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KNOWLEDGE INNOVATION COMMUNITY

Climate-KIC Australia is a Knowledge Innovation Community dedicated to identifying and supporting innovation that helps society address climate change.

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ClimateWorks Australia is an expert, independent adviser, committed to helping Australia and our region transition to net zero emissions. It was co-founded through a partnership between Monash University and The Myer Foundation and works within the Monash Sustainable Development Institute.