



# Export Powerhouse: Australia's \$333 billion opportunity

## Executive Summary

Australia has the potential to grow a new green export mix worth \$333 billion per annum, almost triple the value of existing fossil fuel exports

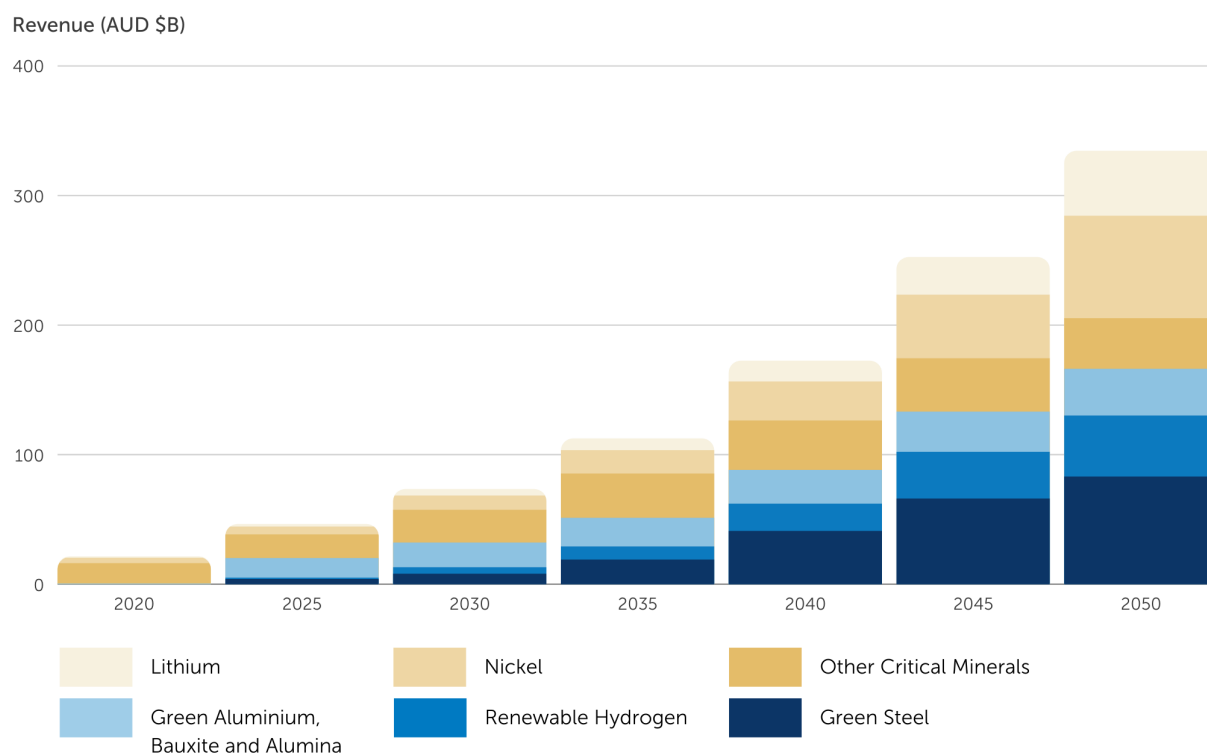
These new green export industries will meet surging demand for zero-carbon products, such as green steel, renewable hydrogen and ammonia, green aluminium and critical minerals that will dominate global economic growth this century.

Beyond Zero Emissions analysis shows that by pursuing an ambitious Go for Gold scenario, Australia can secure a significant share of the global market for these growth commodities. However, we have to rapidly invest to avoid a 'valley of death' in our export profile. If left too late, not only will fossil fuel exports drop off as our major trade partners implement their net zero emissions pledges, other nations will capture early market share of new export industries leaving us with insufficient runway to replace the nation's lost export income.

To seize the opportunity before Australia we must take four priority actions:

- **Recommendation 1: Set a national clean commodity export target of \$100 billion by 2035 to provide a strong investment signal**
- **Recommendation 2: Set green export investment as a priority for DFAT, Austrade and Export Finance Australia**
- **Recommendation 3: Establish a Supergrid Deployment Authority with a \$20 billion lending facility to strengthen the grid and provide transmission capacity industry needs**
- **Recommendation 4: Launch a national Renewable Energy Industrial Precinct activation plan to establish 14 precincts in the next five years**

Figure 1: Australia's green export opportunities in the coming decades

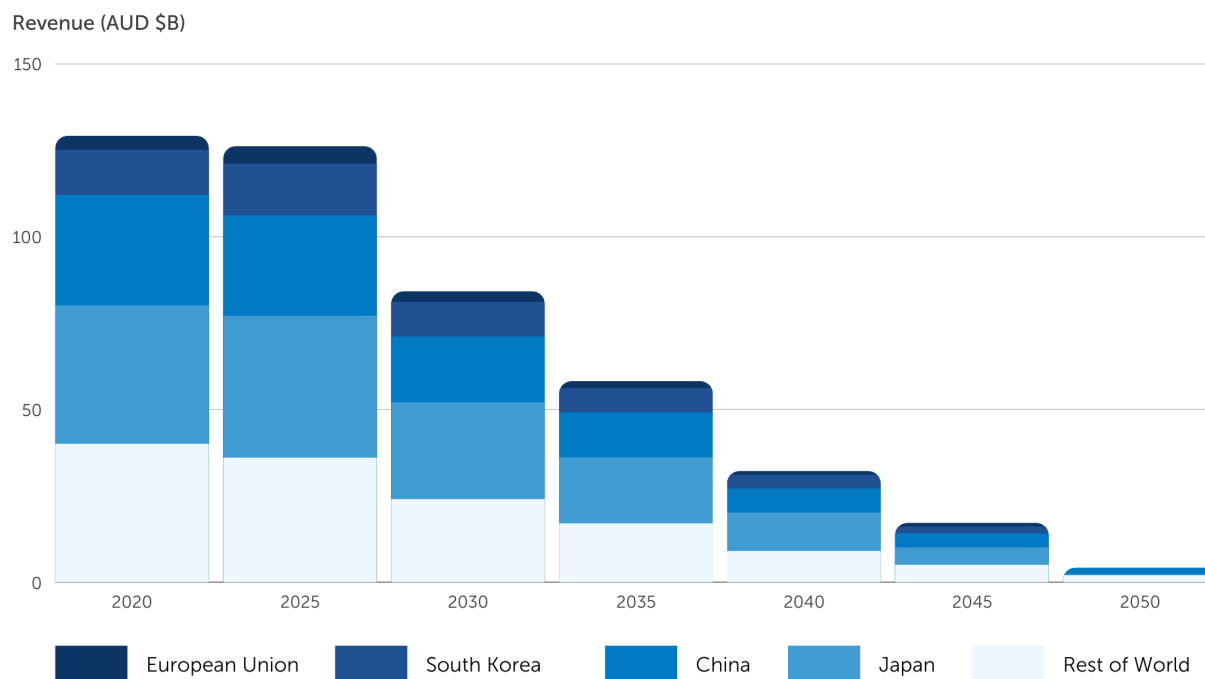


## As the world goes net zero, our \$128 billion fossil fuel industry is at risk

Australia's export profile is highly exposed to demand collapse as the world rapidly pivots to a zero-emissions future. Current climate targets of Australia's key trading partners will wipe \$128 billion a year off Australia's exports unless we invest in alternatives. Currently 39% of Australia's total commodity exports are fossil fuels in the form of thermal coal, metallurgical coal, crude oil and LNG.<sup>1</sup> However, Australia's top five export markets (China, Japan, South Korea, US and the EU) have all set net zero targets and are implementing ambitious policy settings that will drive down demand faster.

Our choice is clear: over the next two decades Australia will lose a third of total commodity export revenue and the jobs that go with them, unless significant policy shifts are made to unlock investments in new export industries. This includes policies that will help reindustrialise the nation and create jobs in the regions by incentivising more value-added onshore processing of mined resources before export.

Figure 2: Fossil fuel exports are projected to decline across key markets



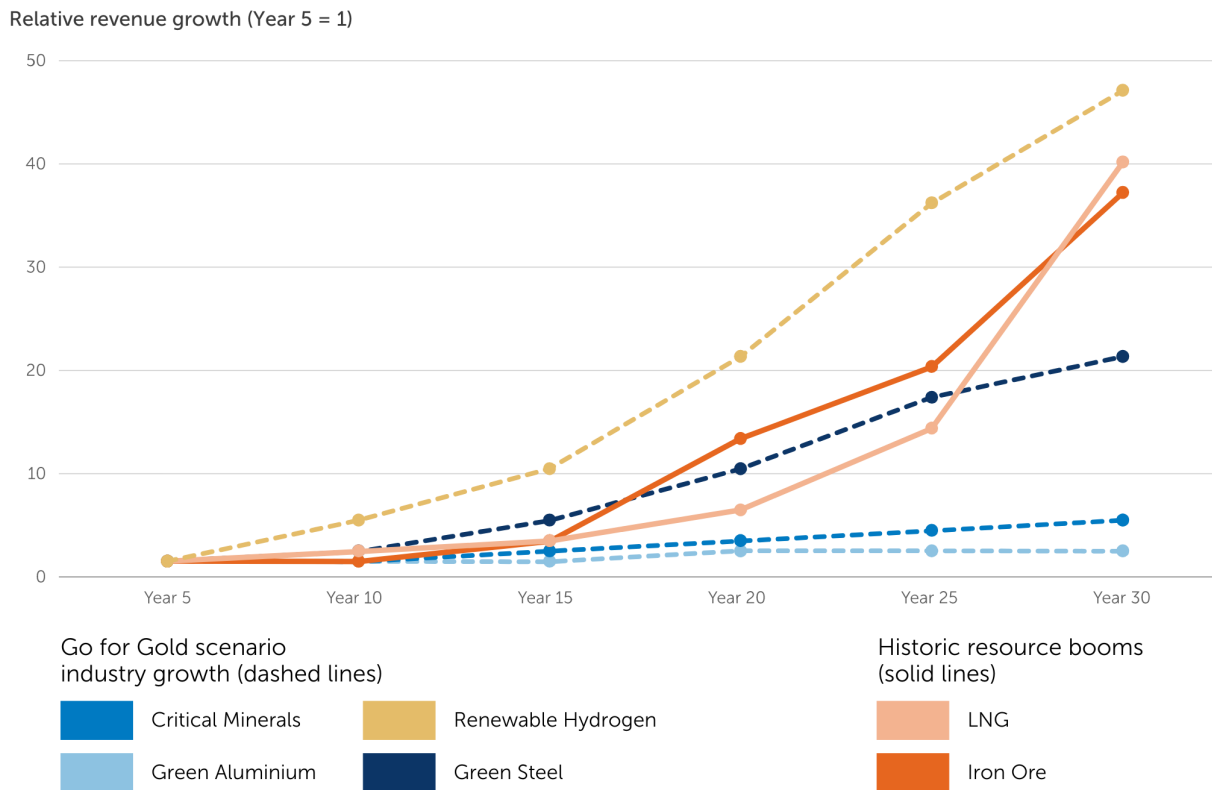
### The good news: a billion-dollar green opportunity is here for the taking

Australia is well positioned to pivot our export strategy and capitalise on these emerging green export market trends. Beyond Zero Emissions research shows that Australia can grow its revenue from new green exports to \$333 billion by 2050. But, we have to move quickly. The global race has started and our competitors are already moving fast to attract investment and secure market share.

Australia’s unique advantage is that we have recent experience of building global export industries from scratch. As recently as 2000, iron ore exports constituted only 9% (\$5 billion) of Australian exports but by 2019 they made up more than 35% of total exports and we have seen the value grow 20 fold to \$100 billion.

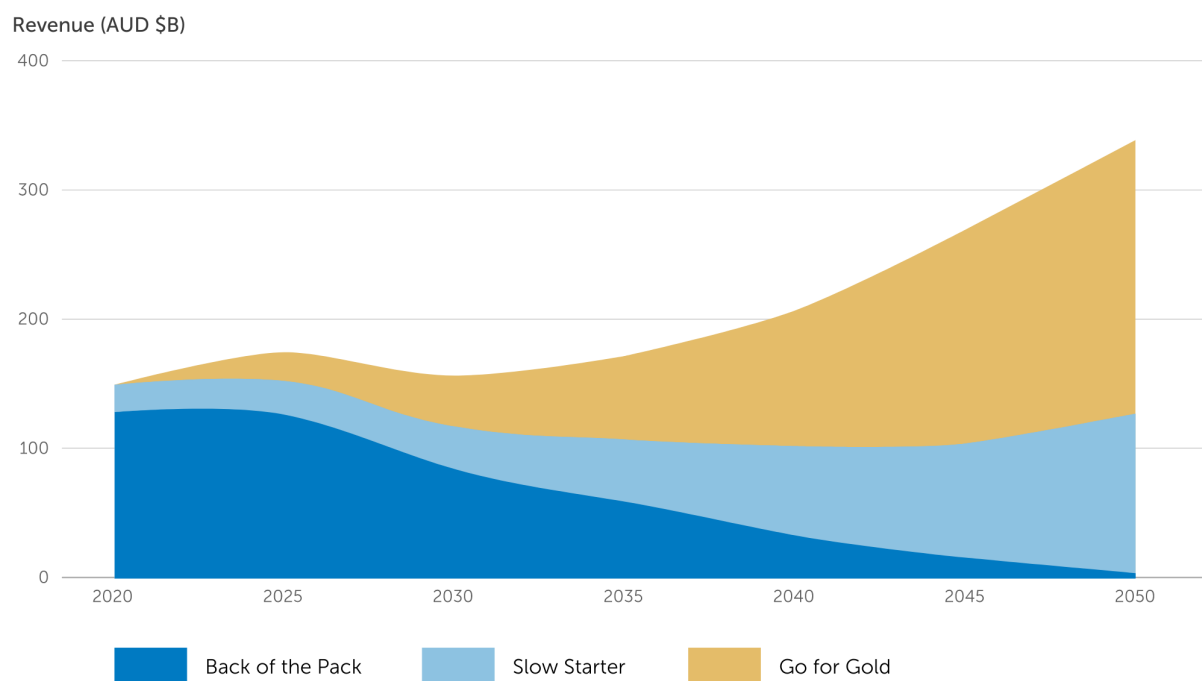
Australia has a strong track record of achieving exponential industrial growth when a clear political direction is set and policy settings are aligned to unlock growth. Figure ES3 provides the historical growth of iron ore and LNG exports over the last 25 years compared to our Go for Gold scenario. The growth trajectory is well within historical performance and in fact is conservative for the majority of the export goods.

Figure 3: Go for Gold growth trajectory is comparable to historic resource booms



The opportunity before Australia now is even larger than the recent boom in demand from China for iron ore. In addition to the financial benefits, providing the goods to support our partners in their decarbonisation efforts will go a long way to restoring Australia’s international reputation. As the world shifts to a zero-carbon economy, we are presented with a once in a lifetime opportunity to capitalise on Australia’s abundance of competitive renewable resources, rich mineral wealth, and a highly skilled industrial base and workforce. We can use these ingredients to rapidly build a new export industry and leverage Australia’s internal manufacturing capabilities.

Figure 4: The three export scenarios explored in this report



To capture this growing momentum towards zero-emissions markets, Australia needs a cohesive industry strategy and an ambitious climate target to keep up with our key trading partners, else risk being left behind. This was starkly evident in August 2021 when BHP announced its divestment of oil and gas exposures, write downs on coal, and an investment pivot to future facing new commodities such as copper and potash.

In this report, we have explored three possible futures for Australian exports (Figure ES4):

1. **Go for Gold:** Strong commitment to a zero-emissions export vision, fast tracking public and private investment into infrastructure, facilities/plants, technologies and upskilling
2. **Slow Starter:** No unifying goal, some growth potential but Australia misses out on key market share, resulting in \$200 billion less annual revenue than the Go for Gold scenario
3. **Back of the Pack:** A continued reliance and focus on fossil fuel exports

Australia is an energy rich nation with extensive fossil fuel and renewable energy resources. The global shift to a zero-carbon future and the introduction of carbon reduction policies and carbon border tariffs means that demand for fossil fuel exports are forecast to collapse in coming years while creating boom conditions for zero-carbon commodities. Australia has the unique opportunity to capitalise on our engineering know-how to deliver global scale new resource projects and out compete carbon-heavy exporters.

## Recommendations

1. **Setting a national export target of \$100 billion** for renewable hydrogen, green steel, green aluminium, and critical minerals by 2035 is an important first step. A target will send a clear signal to investors and project developers that Australia is open for clean commodity business and build Australia's reputation as an attractive investment destination for developing zero-emissions goods.
2. **Set green export investment as a priority for DFAT, Austrade and Export Finance Australia.** This is a vital step in aligning our export targets to the ambition of our key trading partners (Japan, South Korea, US, EU, and China) and cementing Australia's place in their decarbonised supply chain.
3. **Establish a Supergrid Deployment Authority** with a \$20 billion lending facility and a remit to undertake large scale investments in grid infrastructure. A strong grid is the key to supercharging growth in the zero-emissions commodity exports.
4. **Launch a five-year national rollout of Renewable Energy Industrial Precincts in 14 priority regional locations.** The rollout needs to designate precincts, incorporate fast track planning, coordinate infrastructure investment and upgrades, and industry transition support. These precincts will become the industrial engines which power Australia's clean zero-emissions export market.

In the three decades leading to 2050, the world will decarbonise. Australia can choose to become a green export powerhouse and reindustrialise the nation or miss our chance by not acting today.

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## The Business Imperative

### Australia's current export profile is dangerously exposed

As the world rapidly pivots to a zero-emissions future, Australia's export profile is exposed to demand collapse. China, Japan and South Korea along with the US and Europe (including UK) account for \$89 billion or 70% Australia's total fossil fuel exports.<sup>3</sup> All have announced net zero targets by 2050, except China which set their target by 2060 (Table 1).

This means that over the coming decade, the trade of Australian goods will increasingly be affected by their carbon content, either through regulatory measures, corporate targets as well as investors and consumer pressure to decarbonise. This will be further accelerated by the introduction of carbon border adjustment mechanisms (CBAM); first in Europe<sup>4</sup> but with equivalent mechanisms now under consideration in Japan, South Korea, UK and the US.<sup>5,6,7</sup>

**Table 1: Australia's top trading partners and their net zero targets**<sup>8,9,10,11,12,13</sup>

Trading Partner	Export Market Share (%)	Net worth 2018–19 (A\$ billion)	Net Zero Target	Target by 2030
China	32.6	153.2	2060	Peak emissions
Japan	13.1	61.7	2050	46% Reduction (vs 2013)
EU	7.1	33.4	2050	55% Reduction (vs 1990)
South Korea	5.9	27.8	2050	*40% Reduction (vs 2017)
US	5.3	24.7	2050	50% Reduction (vs 2005)

\*Proposed

At present, Australia may be experiencing minimal impact of emission targets of our top trading partners. However, significant interim cuts by 2030 (50-52% for the US, 46% for Japan, 40% for South Korea) present a material risk that Australia's carbon exports will evaporate in the coming decade. Australia's largest coal producing state, NSW, has materially reduced its coal revenue forecast with the potential for no further demand after 2042.<sup>14</sup> In fact year-on-year shrinking of global fossil fuel forecasts<sup>15,16,17</sup> may indicate a persistent "blindspot" in the market that is failing to properly anticipate collapsing demand.

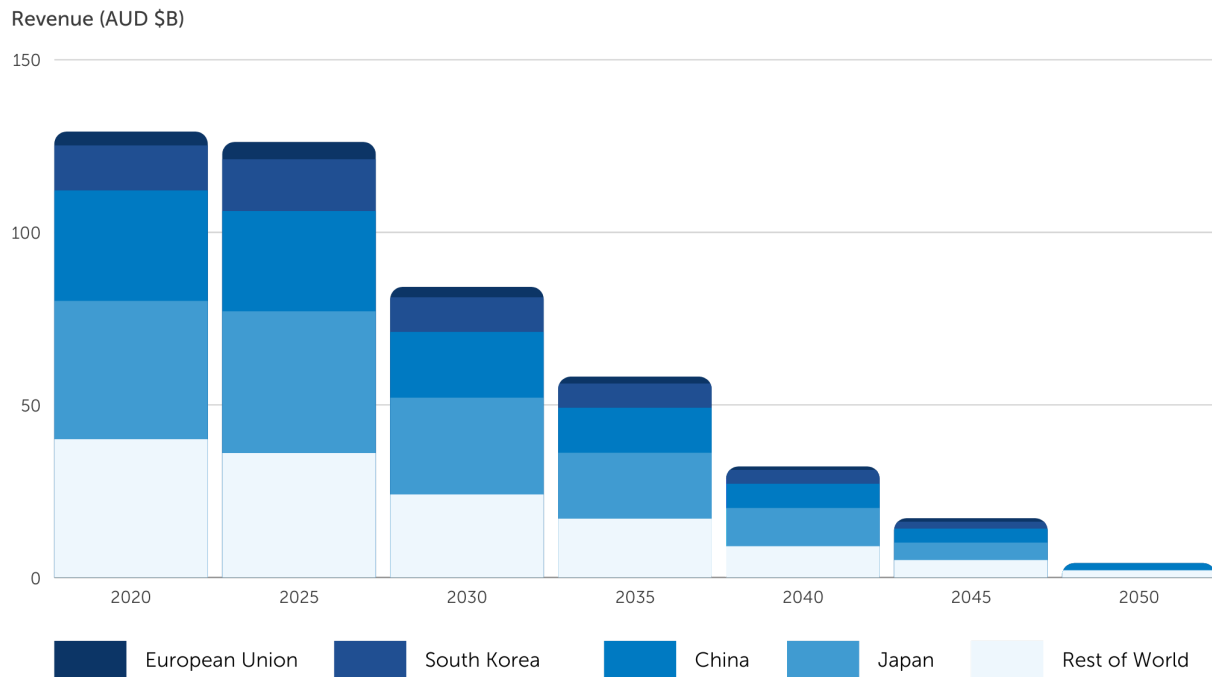
Japan, the largest importer of Australian gas and coal, has recently issued a revised energy mix target for 2030. This revised target will cut coal and gas use by more than 40% compared to 2019<sup>18</sup>, or in dollar terms an equivalent loss of \$17 billion of fossil fuel exports in the next 10 years alone.

We calculate that fossil fuel export revenue to our top five trading partners in 2050 will be only 2% of what it is currently: \$2 billion versus \$89 billion. This is likely a conservative estimate as it only considers the current policy settings of trade partners and not the increasingly stronger calls to action from bodies such as the International Energy Agency (IEA) and Intergovernmental Panel on Climate Change (IPCC).



Figure 1 displays this sharp decline and represents a dramatic market loss that places the jobs and livelihoods of over 130,000 Australians at risk<sup>19</sup> with potential flow-on effects to close to one million workers in related industries<sup>20,21</sup> unless we invest in new opportunities.

Figure 1: Going, going, gone: the collapse of fossil fuel export revenue



While there may be potential to replace some of this reduction with demand from alternative export markets, there's strong evidence these too are pivoting to a zero-carbon future:

- India flagged in 2020 that imports of coal will cease by 2024<sup>22</sup> and would implement market reforms to support the swift deployment of renewables. In August 2021, they followed this up with the pledge of energy independence by 2047.<sup>23</sup>
- Taiwan is actively planning for net zero emissions by 2050.<sup>24</sup>
- Singapore aims to be net zero by the second half of the century.<sup>25</sup>
- Vietnam has signalled a strong reduction in fossil imports to cut emissions.<sup>26</sup>
- The Philippines has announced a moratorium on new coal fired power generation.<sup>27</sup>

Coal fired power generation is becoming increasingly difficult to finance.<sup>28</sup> At the same time, the cost of renewables is expected to be 56% cheaper than new coal in India by 2030.<sup>29</sup> It is high risk to rely on coal as a long term export commodity.

Similar to coal, the future of gas exports are jeopardised by the falling prices of renewable energy. Per unit of energy, it has been cheaper to generate power from renewables since 2019.<sup>30</sup> Even while accounting for storage costs for renewables, gas is only competitive until 2026 when

it will be overtaken by firmed renewables.<sup>31</sup> A forecast global oversupply of LNG<sup>32</sup> means Australia's expensive gas exports will struggle to compete in the global market.<sup>33</sup>

In short, we will see a near total collapse in demand for Australia's coal and gas over the coming decades. The carbon intensity of Australia's economy makes it uniquely exposed in a zero-carbon global economy. But equally, our unique abundance of renewables sets the country up to become a green export powerhouse.

## Demand for green products is accelerating

In the private sector, demand for green products is growing rapidly.<sup>34</sup> Major corporations such as LafargeHolcim,<sup>35</sup> Siemens,<sup>36</sup> Mars,<sup>37</sup> and Toyota<sup>38</sup> are rolling out comprehensive plans to mitigate their supply chain emissions. This is putting pressure on suppliers for similar actions and commitments.<sup>39</sup>

These actions are driving new industrial partnerships. For example Volvo has committed to securing green steel from SSAB's HYBRIT plant<sup>40</sup> while Apple is partnering with Rio Tinto and Alcoa to develop carbon free aluminium.<sup>41</sup> Closer to home BHP has recently announced that it will supply Tesla with sustainable nickel for its batteries,<sup>42</sup> prompting the development of potential wind farms to power its production in Western Australia.<sup>43</sup>

Major investors are recognising these synergies and are accelerating the transition. BlackRock has asked companies "to disclose a plan for how their business model will be compatible with a net zero economy"<sup>44</sup> while the Net Zero Asset Managers initiative — representing \$43 trillion in assets — has committed to aligning their portfolios to net zero by 2050 or sooner.<sup>45</sup>

Countries are now in a race to take advantage of this new wave of investment and technology innovation to achieve a zero-carbon future.

With our abundance of competitive renewable energy and resources, Australia is ideally positioned to supply the quality zero-emissions commodities, such as renewable hydrogen and ammonia, green steel, green aluminium and critical minerals, that the world is demanding. Australian corporate leaders are also taking up the challenge with Fortescue Metals Group pledging a world leading net zero by 2030 target and spending over US\$400 million in 2021/22 alone on zero-emissions technology development.

## The building blocks for a net zero economy

Beyond Zero Emissions have identified a high-grade portfolio of zero-emissions product categories that harness Australia's natural advantages, meet global demand and provide scale in terms of revenue and job creation opportunities. These are the building blocks for a net zero global economy.

- **Critical minerals:** we can export the minerals needed for the zero-carbon economy, such as lithium, nickel and rare earths, extracted using zero-emissions methods and

value added through onshore processing. These minerals have substantial reserves and will prove vital for the new generation of clean-tech products such as batteries, electric motors and other key supply chains.

*“Australia has the minerals to power the renewable energy age throughout the world in the coming years...The opportunity for Australia is extraordinary and now is the time to seize it.”* Robyn Denholm, Tesla chairman<sup>46</sup>

- **Renewable (green) hydrogen and ammonia:** we can export zero-emissions hydrogen produced from sustainably sourced water and electricity (electrolysis) powered by renewable energy. Renewable hydrogen may also be converted and exported as green ammonia.

*“Australia holds the key to Korea’s hydrogen needs – a secure market of hydrogen and, in particular, green hydrogen.”* Australia - Korea Business Council<sup>47</sup>

- **Green steel:** we can export zero-emissions iron and steel produced with renewable energy and hydrogen. This capitalises on our iron ore deposits, industrial capabilities and abundant renewables.

*“Australia is in an absolutely unique position to scale green steel...We produce over 40 per cent of the world's iron ore. Our potential green energy and hydrogen resources are immeasurable. And the timing is right.”* Dr Andrew Forrest, Fortescue Metals Group<sup>48</sup>

- **Green aluminium:** we can export the entire green aluminium supply chain, starting with renewably mined bauxite and value adding up the chain to zero-emissions alumina and aluminium. This family of green aluminium exports builds on existing industry and demand.

*“We’ve seen this coming from the market, our customers, shareholders, financial markets, NGOs, you name it. That means in the end it will affect the bottom line.”*

Katherine Fog, Senior VP at Norsk Hydro<sup>49</sup>

The economic potential from this high-grade portfolio of value-added export goods alone more than offsets our fossil fuel exports while providing valuable long-term economic opportunities for our manufacturing and regional communities. But Australia must commit to creating the right regulatory framework so that the private sector can make sound investments now.

There is already growing momentum. A recent report from the Investor Group on Climate Change described an Australian investor community increasingly focused on climate action and an equitable transition.<sup>50</sup> At the same time, industry support for initiatives such as WWF’s Materials & Embodied Carbon Leaders’ Alliance<sup>51</sup> and ClimateWorks Energy Transition Initiative<sup>52</sup> are strong indicators of the appetite from construction and heavy industries to decarbonise their products for both domestic and overseas exports.

## Setting a new bar for environmental, social and governance standards

While the development of zero-emissions export goods will help reduce global emissions, it is critical that these new industrial developments are held to high sustainability and environmental standards and benefit local communities. This is particularly important as Environmental, Social and Governance (ESG) expectations for investment and stakeholders continue to grow.

Australia must continue the evolution of best practice from our long history of extractive industries and aspire to set new global standards. This includes careful consideration of how we power, mine, process and importantly, rehabilitate the areas of industrial activity while ensuring community consultation and providing community benefits.

Some example considerations include but are not limited to:

- **Sustainable water use for the production of hydrogen**, particularly for inland sites. Projects should take into account sustainable water allocations for hydrogen production and how to adapt them to a changing climate. Projects that rely on desalination of sea water will also need to consider their impacts on coastal sites.
- **Impact of renewable energy development**. The electrification of industry will require many gigawatts of new renewable energy along with firming and transmission. Consultation and building in community benefits will be key to any project's success, while new solutions can bring synergies, like co-locating grazing with solar farms.
- **Obtaining free, prior and informed consent** from First Nations Peoples and setting an example for international best-practice for land use partnerships, delivering equitable and long-term benefits to all.
- **Impact of mining on the land, waterways, Indigenous history and local communities**. Extensive planning and consultation should be undertaken prior to new activities. Projects should consider their impact on the local environment and communities and the rehabilitation of sites impacted by extraction.
- **Increasing consideration for the circular economy as a key part of diversification**. Aluminium, steel and critical minerals are primed for reuse and recycling. Designing products and systems for the circular economy will reduce emissions and create economic opportunities for Australia as a leader in recycling and reusing products such as solar panels, batteries and electronic components, as well as steel, aluminium, plastics, advanced biofuels and construction materials.

By setting these global benchmarks, we not only help protect our environments and help deliver economic outcomes to local communities, we also become more attractive to investors. As global markets increase their expectations of an equitable decarbonisation, the guarantee that our green export goods are delivered without the exploitation of labour, communities or environment is a powerful market advantage.

## Australia needs a cohesive industry strategy

To capture this growing momentum towards zero-emissions markets, Australia needs a cohesive industry strategy to match our key trading partners and stay ahead of our competitors, else risk being left behind. Fortunately, we are perfectly positioned to become a global leader in supplying green hydrogen and clean commodities to a decarbonised world. Carbon trading and carbon border adjustment mechanisms may existentially threaten our fossil fuel exports but also represents an economic opportunity if Australia makes use of our abundant renewables to out-compete export nations that remain carbon-heavy.

Industry development policies are already at work in other parts of the world so we need to act now. By aligning our ambition of green exports with the growing decarbonisation demand of our key trading partners, we can activate global market synergies, supplying vital green commodities for their industry activities.

- **UK Net-Zero Industrial Cluster (UK):** Plan for a green industrial revolution with industrial clusters playing a monumental role as it mobilises £12 billion (AU\$22 billion) of government investment to create up to 250,000 jobs.<sup>53,54</sup>
- **Green Growth Strategy (Japan):** Implementing Green Innovation Fund of 2 trillion yen (AU\$25 billion) to deliver on decarbonising key growth sectors such as hydrogen, offshore wind, automotives and batteries.<sup>55</sup>
- **Green New Deal (South Korea):** 43 trillion won (AU\$50 billion) to create over 600,000 jobs by 2025 with a heavy focus on industrial decarbonisation through data platforms, artificial intelligence and smart, low-carbon industrial complexes.<sup>56,57</sup>
- **Just Transition Mechanism (EU):** Mobilising over €65 billion (AU\$100 billion) to help carbon intensive regions to transition through re-skilling, low-carbon technology support, renewable investment, easier access to loans and investing in innovation.<sup>58</sup>

## Three very different trajectories

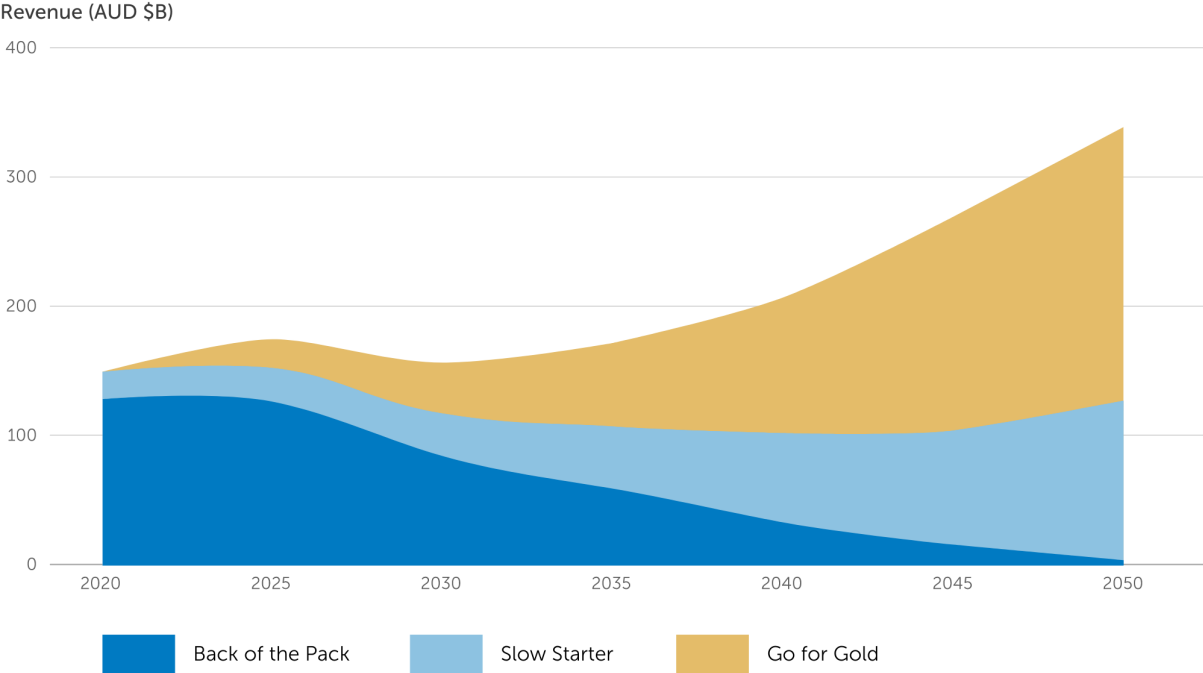
Australia's potential future export trajectories are mapped in Figure 2, comparing the export revenues from the two potential export scenarios along with the decline of fossil fuels in the Back of the Pack scenario. This figure highlights the tremendous opportunity for Australia if we set a strong vision and embrace a nation wide diversification program.

**Go for Gold:** Committing to a zero-emissions export vision with clear planning and strong investment, both public and private, on infrastructure, facilities/plants/process lines, technologies and upskilling of workers.

**Slow Starter:** Tentative approach without a unifying trajectory. Some growth is still projected but Australia misses out on key market share that has been captured by early movers.

**Back of the Pack:** Australia continues to focus on fossil fuels.

Figure 2: Revenue projections from the zero-emissions export products in three scenarios



Failure to seize this global market opportunity would result in a much poorer Australia, short on revenue while squandering our renewable advantages to competing mineral and renewable energy players.

## Scenario: Go for Gold

### Australia's advantage in a zero-carbon world

Australia's core competitive advantage in a zero-carbon economy is our abundance of high quality, distributed and competitive renewable energy. This translates to a supply of zero-carbon energy generation at a price and quantity that most competitors cannot match.<sup>59,60,61</sup> This is supported by an extensive electricity network — enabling these renewable resources to be shared across thousands of kilometers — as well as the nation's vast mineral wealth and skill base. When combined with our engineering track record of building reliable world-scale resource export projects and ESG practices, Australia is in a unique position to supply the world with zero-emissions energy and products.

Many companies decarbonising their products and downstream materials have already recognised these unique advantages Australia offers.

- Sun Metals zinc refinery in Townsville committed \$200 million to a 124 MW solar farm<sup>62</sup> and is currently expanding to develop renewable hydrogen and wind generation facilities, supplying 86% of the refinery power needs and helping to decarbonise its products to South Korea.<sup>63</sup>
- Alcoa has recently partnered with ARENA to fund a \$28 million project to investigate the use of renewable electricity to help power the Wagerup alumina refinery.<sup>64</sup> This would help cut emissions from the process by up to 70% and help reduce their carbon footprint for exports around the world.<sup>65</sup>

*'Australia's tremendous amounts of solar and wind resources offer great opportunities for renewable energy projects as the world looks to a clean, green future. Australia has great potential to become a world-leading provider of renewables.'*

Kiwon Park, CEO, Sun Metals Corporation

Much of what has long made Australia an attractive destination for resource companies also makes us an attractive destination for global companies investing in the zero-carbon economy. Australia boasts a stable economy, a highly skilled and innovative workforce with extensive experience in heavy industry and energy exports and world class rail, freight and port facilities that allow us to export vast amounts of goods all around the world. Australia can make the most of these advantages to win the race as supplier of choice in a global net zero economy. This will

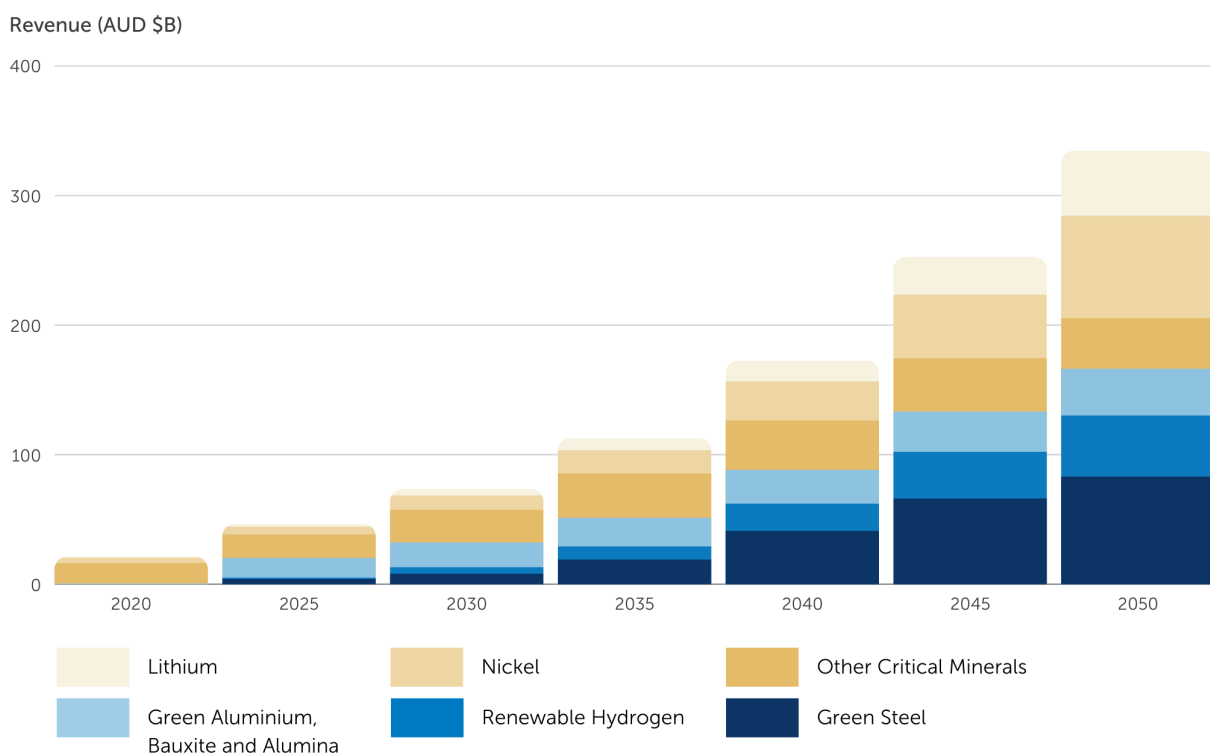
align exports with growth markets, stabilise regional economies, and create long-term good quality export jobs.

## Green exports worth \$333 billion by 2050

To highlight the economic benefits of the Go for Gold scenario, we have modelled the potential trajectory of export revenue from the four identified zero-emissions product categories: critical minerals (including lithium and nickel), renewable hydrogen, green steel and green aluminium (including alumina and bauxite).

In this scenario, we see a rapid expansion based on a conservative share of forecast global demand and modest increase in share of the value chain. Figure 3 highlights the potential revenue growth from our green exports from \$21 billion in 2020, to \$72 billion by 2030 and \$333 billion by 2050, almost triple our current fossil fuel exports of \$128 billion. (For more details on the modelling, refer to the appendix. Due to the high revenue contribution from nickel and lithium, these are graphed separately from the other critical minerals.)

**Figure 3: Breakdown of zero-emissions product export revenue by product category in the Go for Gold scenario**



Investing early in front-end opportunity evaluation across a portfolio of new technologies will put Australia in an excellent position to capitalise on these emerging markets as they develop, at minimal risk. While there is uncertainty around how these markets will develop, by investing early across a range of clean commodities Australia can quickly capitalise on emerging market



opportunities. Their long maturation phase also means final investment decisions don't occur until later in the decade, minimising material capital exposure.

By planning and investing in key early infrastructure, technologies and a firm zero-emissions commitment, we can attract more local and international investment across our portfolio of green export goods. This lays the foundations for a strong and sustainable economy that recognises the shifting global market while capitalising on our natural advantages with a robust plan for diversification.

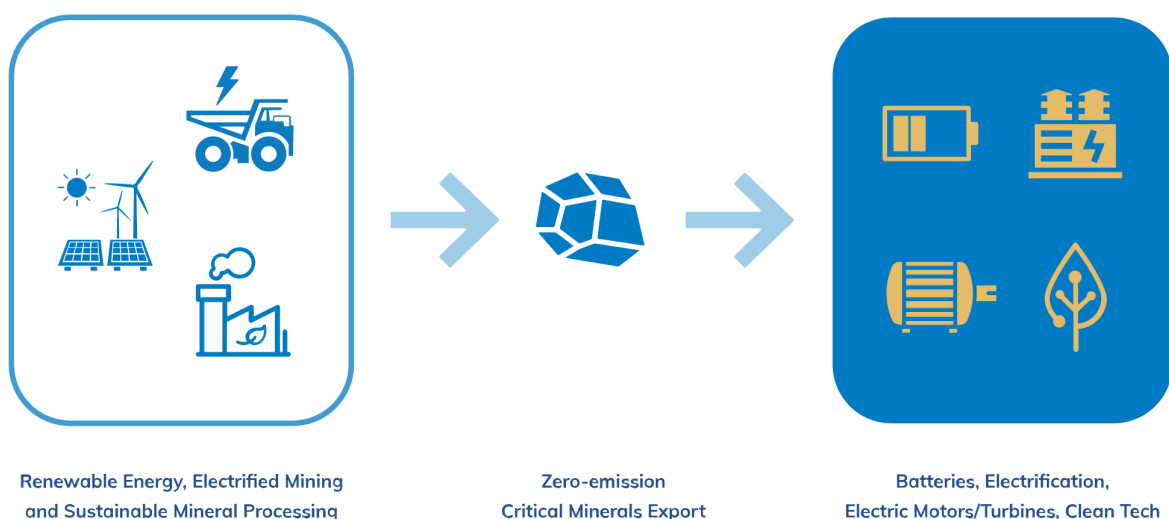
## The star earners of green exports

### Critical minerals

To achieve international commitments of net zero by 2050, it is estimated that over three billion tonnes of minerals and metals will be needed to deploy wind, solar and geothermal power, as well as energy storage, required for achieving a future with warming below 2°C;<sup>66</sup> noting the shift in 2021 of now US\$88 trillion of global capital to pledging to align investments, insurance and financial services to a even more ambitious 1.5°C target.

While commodities such as aluminium and steel remain key ingredients, these clean technologies require a whole range of critical elements to function properly. These elements, also known as “critical minerals” are used in small quantities but are high value. Well known examples include lithium (for batteries) and copper (for electrification), with opportunities also in rarer elements such as neodymium (for turbines/motors), graphite (for batteries) and vanadium (for energy storage). The key to their success and marketability will be best-in-class ESG practises, the use of zero-emissions/electrified mining and sustainable processing methods, all powered by renewables (Figure 4).

Figure 4: Zero-emissions critical minerals and their potential applications



## The international demand for critical minerals

Demand for critical minerals is expected to grow rapidly in the coming decades with a recent IEA report predicting the “overall needs for critical minerals could increase by as much as six times by 2040”,<sup>67</sup> eventually contributing to over US\$250 billion in global revenue by 2040.<sup>68</sup>

The growth of lithium-ion batteries alone is expected to grow to US\$350 billion by 2050 with key trading partners in our region, such as South Korea, Indonesia and Thailand, articulating a vision to be leaders in battery manufacturing.<sup>69,70,71,72</sup> There will be increased demand for critical minerals in these countries and around the world. Importantly, demand will be particularly high for countries that can deliver critical minerals inline with best practises as the industry moves to prioritise ESG goals.<sup>73</sup> This is best represented by initiatives such as Climate-Smart Mining<sup>74</sup> and Charge On Innovation Challenge<sup>75</sup>, encouraging technology innovation for fuel switching and best practices for reducing the carbon and environmental footprint of critical minerals.

## Australia’s potential in critical minerals

Critical minerals are a massive market opportunity for countries like Australia with commercial quantities of 16 of the minerals used in solar panels and 10 of the elements required to build lithium-ion batteries. Production of key minerals, such as graphite, lithium and cobalt, could increase by over 500% by 2050, to meet the growing demand for clean energy technologies.<sup>76</sup> Australia is ideally placed to feed this exponentially growing demand in the net zero economy, with some of the largest reserves of lithium, copper, nickel and cobalt in the world, close access to major producers of renewable technologies in Asia and the ability to deliver higher ESG standards than competitors.<sup>77</sup>

Critical minerals also present Australia with a chance to move up the supply chain to massively value add to our raw materials. For example, despite being the world's largest supplier of lithium ore (spodumene), we are capturing only 0.53% of the lithium-ion battery value chain.<sup>78</sup> Recent remarks from Tesla indicated that if we were able to onshore process our lithium ore exports, we could convert a trade revenue of US\$100 million to US\$1.7 billion.<sup>79</sup>

Investing in sustainable downstream refining and processing facilities for critical minerals, in addition to their mining, would add significant value to our mining and industrial communities. However, to fully capture the global markets, we need to ensure these processes are aligned with international decarbonisation efforts. Fortunately, development of this market is already underway with innovative local projects such as the Dubbo Project,<sup>80</sup> Element 25,<sup>81</sup> Sun Metals,<sup>82</sup> and Alpha HPA<sup>83</sup> developing unique sustainable processing solutions.

If done correctly, Australia’s ability to co-locate mining and processing facilities while powered by low-cost renewables with good ESG practises, would provide our products with a distinct economic, carbon and social due diligence advantage over other exporters like China and the Congo that currently supply the vast majority of these critical minerals.<sup>84</sup> The ability to process key minerals and move down the value chain also provides sovereign capability, helping to secure resilient supply chains for our trading partners while locking in economic and job

creation opportunities.<sup>85,86,87</sup> Interest is already gaining speed with South Korean companies LG Energy Solution and POSCO investing over \$1 billion into Australian critical minerals.<sup>88</sup>

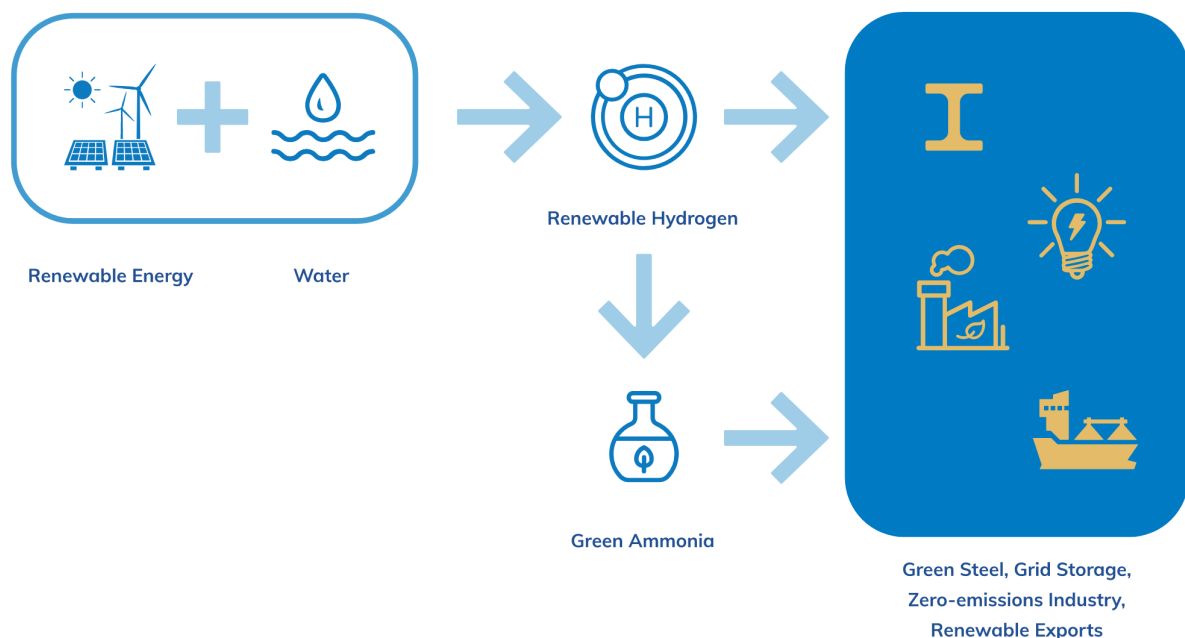
The critical minerals sector will be vital for decarbonisation and the adoption of advanced clean technologies. Australia's abundance of high-demand minerals, coupled with our capacity to electrify the mining and processing steps with cheap renewables, presents an immense opportunity to fuel global markets while feeding our domestic industrial transition. They form a critical part of the next generation of high value global trade. Our ability to invest and capture these mineral resources and their downstream value chains will be pivotal to the success of Australia as a green export powerhouse.

## Renewable hydrogen

Renewable hydrogen is a gateway fuel to a zero-carbon economy. Its chemical properties are critical in the production of green steel, as a fuel for freight and as conduit for electricity and energy storage. More applications can be unlocked through conversion to green ammonia, opening up uses in industrial chemical feedstocks as well as exports. The flexibility of renewable hydrogen for this multitude of applications means it is a key ingredient for decarbonisation.

Renewable hydrogen is produced through electrolysis using renewable electricity and water. Green ammonia can then be produced from renewable hydrogen by reacting with nitrogen from air (Figure 5).

Figure 5: Renewable hydrogen and its potential applications



## The international demand for renewable hydrogen

Global hydrogen demand for renewable hydrogen could reach 801Mt in 2050, a 900% increase from 2020.<sup>89,90</sup> Bloomberg predicts that over \$900 billion of grey, blue and green hydrogen projects are in the global pipeline and although these won't all come to fruition, strategies such as the EU's €430 billion by 2030 Hydrogen Strategy, are setting the scene for a global renewable hydrogen economy.<sup>91</sup>

## Australia's potential in renewable hydrogen

Internationally competitive access to wind, sun and land, positions Australia as a leading supplier of renewable hydrogen, particularly when compared to other industrial countries such as Japan and South Korea which have comparatively small reserves of renewable energy. Australia also has an established history in the gas export industry with transferable skills and infrastructure. Many of Australia's advantages have been confirmed by GHD Advisory and BP Australia, with their analysis confirming a "strong potential for green hydrogen export".<sup>92</sup>

Japan, South Korea and Germany in particular are looking into renewable hydrogen as a zero-emissions energy alternative and represent a perfect market for Australian renewable hydrogen.<sup>93</sup> Our long trade history has built trust in Australia's capability to deliver and a warm trade relationship. When combined with our renewable generation capabilities, Australia is an ideal investment partner for renewable hydrogen, prompting initiatives such as the Australia-Japan Joint Statement of Cooperation on Hydrogen and Fuel Cells,<sup>94</sup> the Letter of Intent for Hydrogen Cooperation between Australia and South Korea<sup>95</sup> and the German-Australian Hydrogen Innovation and Technology Incubator.<sup>96</sup>

Industry collaborations and partnerships are already underway, some of which include:

- Kawasaki Heavy Industries with Origin Energy: Green liquid hydrogen export project at Townsville<sup>97</sup>
- Ark Energy (subsidiary of Korea Zinc): SunHQ Hydrogen hub in North Queensland<sup>98</sup>
- Iwatani with Stanwell: Queensland Green Hydrogen Project in Gladstone<sup>99</sup>
- IHI Corporation with Fortescue: Green ammonia supply chain in Bell Bay<sup>100</sup>
- HySupply: Renewable hydrogen supply chain between Australia and Germany<sup>101</sup>

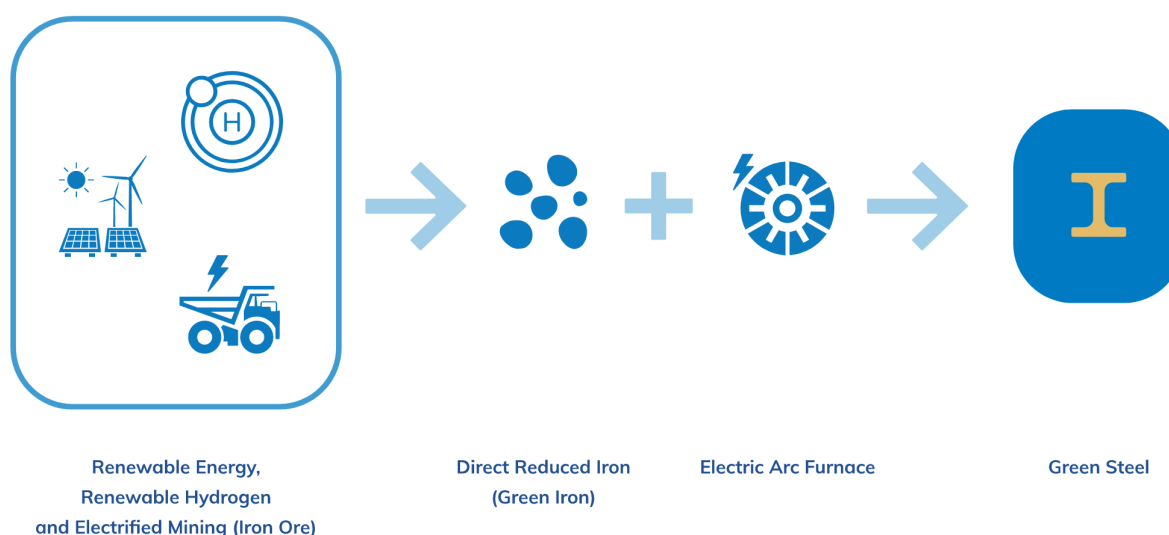
Renewable hydrogen and green ammonia is a versatile and valuable resource with enormous potential for Australia. As costs for renewable hydrogen production decrease, it will increasingly displace fossil fuels as the preferred energy carrier for international trade in a decarbonised world. Australia is well placed to capture this massive market given its strategic location in the Asia-Pacific region. Seizing this opportunity would guarantee long term zero-emissions exports and jobs for our regional communities.

## Green steel

Steel is the most used and recycled material in the world with a wide array of applications largely concentrated in the automotive and construction industries. Steel markets are set to soar in the next 20 years increasing by more than a third by 2050.<sup>102</sup> At the same time, iron and steel are major sources of emissions, contributing 2.6 billion tonnes of CO<sub>2</sub> per year or about 7% of global emissions.<sup>103</sup>

Zero-emissions green steel can be produced using hydrogen and renewable electricity (Figure 6); the intermediary product of green iron is also a potential export product. Iron ore from zero-emissions/electrified mining reacts with renewable hydrogen to produce direct reduced iron (DRI) or green iron. This is then converted to green steel through use of a renewable powered electric arc furnace (EAF). This process for green steel is commonly referred to as the DRI-EAF method (Figure 6).

Figure 6: Green steel (and green iron) production



### International demand for green steel

With decarbonisation efforts accelerating, key industry players have begun the race to scale and produce zero-emissions green steel. In Sweden, the SSAB HYBRIT initiative is making headlines by being the first in the world to produce steel using 100% renewable hydrogen.<sup>104</sup> Others such as Thyssenkrupp are upgrading their facilities to run on renewable hydrogen, requiring €2 billion worth of investment by 2030<sup>105</sup> while ArcelorMittal plans to contribute €1 billion towards a full-scale zero-emissions steel plant.<sup>106</sup>

At the same time, customers are increasingly showing an interest in green steel products to decarbonise their supply chains, often with a willingness to pay a price premium for green steel through initiatives such as Ecolabel or SteelZero.<sup>107</sup> End users such as Volvo,<sup>108</sup>

Mercedes-Benz,<sup>109</sup> Severfield PLC<sup>110</sup> and Multiplex Construction Europe<sup>111</sup> have all signalled their intentions to source green steel, some from as early as 2025.

### Innovations in green steel

There are several methods for creating green steel. Molten oxide electrolysis (MOE), or the production of steel using electricity alone, is one promising new technology. While less commercially established than DRI-EAF, MOE can potentially produce green steel more efficiently and at lower costs.<sup>112</sup> Boston Metal is currently developing this technology and has attracted significant attention with investments from Vale,<sup>113</sup> BMW Group<sup>114</sup> and Breakthrough Energy Ventures, a firm backed by Bill Gates, Jeff Bezos, Michael Bloomberg and others.<sup>115</sup> The company aims to begin full-scale cells by 2024<sup>116</sup> and will be a key player to watch in the green steel space.

### Australia's potential in green steel

As the world's largest exporter of iron ore with 30% of the world's reserves<sup>117</sup> and unparalleled capacity to produce cheap renewable hydrogen, Australia has an unmissable opportunity to lead the global green steel market. Analysis from Grattan Institute's *Start with Steel* report shows that Australia can export close to 100 million tonnes of green steel and green iron, worth \$65 billion a year and create 25,000 new jobs.<sup>118</sup> A recent paper from the Australian Steel Institute has identified that green steel will provide strategic sovereign capacity, economic value add and stable well-paying jobs.<sup>119</sup>

Australian companies are recognising this massive opportunity with leaders like Fortescue Metals Group mobilising to develop and scale up hydrogen and green steel production powered by renewables.<sup>120</sup> They have already achieved a significant breakthrough by successfully producing green iron<sup>121</sup> and are set to accelerate as they invest over US\$400 million in renewable green energy projects in FY22 alone.<sup>122</sup> Momentum behind the Australian green steel market is gaining with players such as GFG Alliance and BlueScope Steel announcing plans of their own worth at least \$200 million.<sup>123,124</sup>

In the past 20 years, iron ore helped drive Australia's economy, boosting our export revenue from \$5 billion in 2000 to over \$100 billion in 2020.<sup>125</sup> Over the next 20 years, green steel can help power a new generation of economic growth, tapping into our abundant renewable resources and capturing this vast new global market.

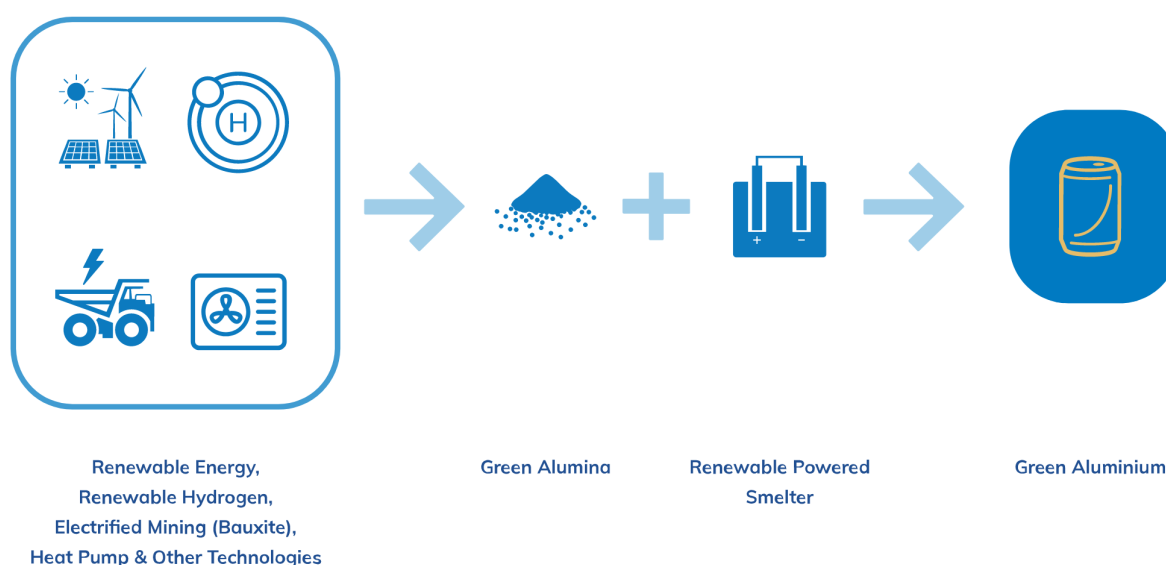
### Green aluminium

Lightweight, versatile and infinitely recyclable,<sup>126</sup> aluminium is another critical but energy intensive material, emitting over 1 billion tonnes of CO2 each year across its value chain, or 2% of global emissions.<sup>127</sup> Demand is set to grow by 80% to over 170 million tonnes by 2050<sup>128</sup> and

is driven by use in automotives, construction and uses in packaging and electronics.<sup>129</sup> In order to satisfy the decarbonisation targets of countries, companies, investors and customers, we need to produce zero-emissions green aluminium; this includes the whole aluminium supply chain, including bauxite, alumina as well as the aluminium metal itself.

Bauxite from zero-emissions/electrified mining is first converted to green alumina via renewable methods (eg. hydrogen, electric heat pumps, concentrated solar etc.). This green alumina can be directly exported or further processed with renewable electricity to produce green aluminium (Figure 7).

Figure 7: Green aluminium production, includes zero-emissions bauxite, alumina and aluminium metal



### International demand for green aluminium

With pressure from emission targets, investors and environmentally conscious customers, companies around the world are pivoting towards green aluminium. For example, Apple, Tetra Pak, Coca-Cola and Nespresso are working to improve the sustainability of aluminium.<sup>130,131,132</sup> At the same time, automotive companies like Toyota, BMW, Audi and Volkswagen are prioritising suppliers that use green energy to produce their aluminium.<sup>133,134</sup> Regardless of the application, green aluminium is becoming a pivotal and highly sought after material.

Suppliers around the world are acting on this demand and scaling up green aluminium production, increasing the share of renewables to their smelters and refineries, as well as investing in technologies that decarbonise the supply chain. For example, EN+ and Rusal have established the Green Aluminium Vision<sup>135</sup> while Alcoa and Rio Tinto are partnering to develop ELYSIS, a carbon free aluminium smelting technology.<sup>136</sup> Many of the leaders in the aluminium industry such as Alcoa,<sup>137</sup> Rio-Tinto<sup>138</sup> and Norðurál<sup>139</sup> are already supplying lower carbon

aluminium and gaining a competitive edge on suppliers that rely on fossil fuels.<sup>140</sup> The race is now on to achieve a fully decarbonised green aluminium product.

### **Australia's potential in green aluminium**

Australia's opportunity to tap into this market is immense. Australia is the world's largest producer of bauxite (aluminium ore) and the largest exporter of alumina (precursor to aluminium),<sup>141</sup> but only produces 2% of the world's aluminium metal.<sup>142,143</sup> Prioritising the use of renewable powered mining for bauxite and adopting zero-emissions processing for alumina, will enable Australia to tap into this global demand for green aluminium and establish ourselves as a key part of the green aluminium supply chain.

Work is already underway with both Alcoa and Rio Tinto engaging with ARENA to fund innovative technologies to decarbonise alumina. This includes mechanical vapour recompression (MVR) to cut emissions by up to 70%<sup>144</sup> as well as using hydrogen to replace natural gas in alumina refineries.<sup>145</sup> At the same time, innovators from Alpha HPA have developed exciting new sustainable processing techniques to produce high purity alumina,<sup>146</sup> a high value product critical for lithium-ion batteries and other clean-tech.

Demand for green aluminium also creates opportunities for our aluminium smelters. By committing to build up infrastructure for a firm renewable-based electricity grid, our smelters can become increasingly competitive — with lower carbon footprints — as they move away from coal towards low cost renewable electricity.<sup>147,148,149</sup> The recent announcement from Tomago Aluminium in the Hunter Valley to move to 100% renewable energy by 2029 is an exciting sign of things to come as industry and communities align towards this zero-emissions opportunity.<sup>150</sup>

Australia's ability to create a vertically integrated value chain for decarbonisation, benefits from co-locating the production of bauxite, alumina and aluminium, and low cost renewable power, mean we have a unique advantage of being a market leader for green aluminium. Our experienced and skilled workforce also means we have all the ingredients for a thriving green aluminium industry in Australia.

### **Early investment and portfolio approach reduces risk**

Australia has a strong and diverse zero-emissions export portfolio with tremendous synergies that few competitors can match.

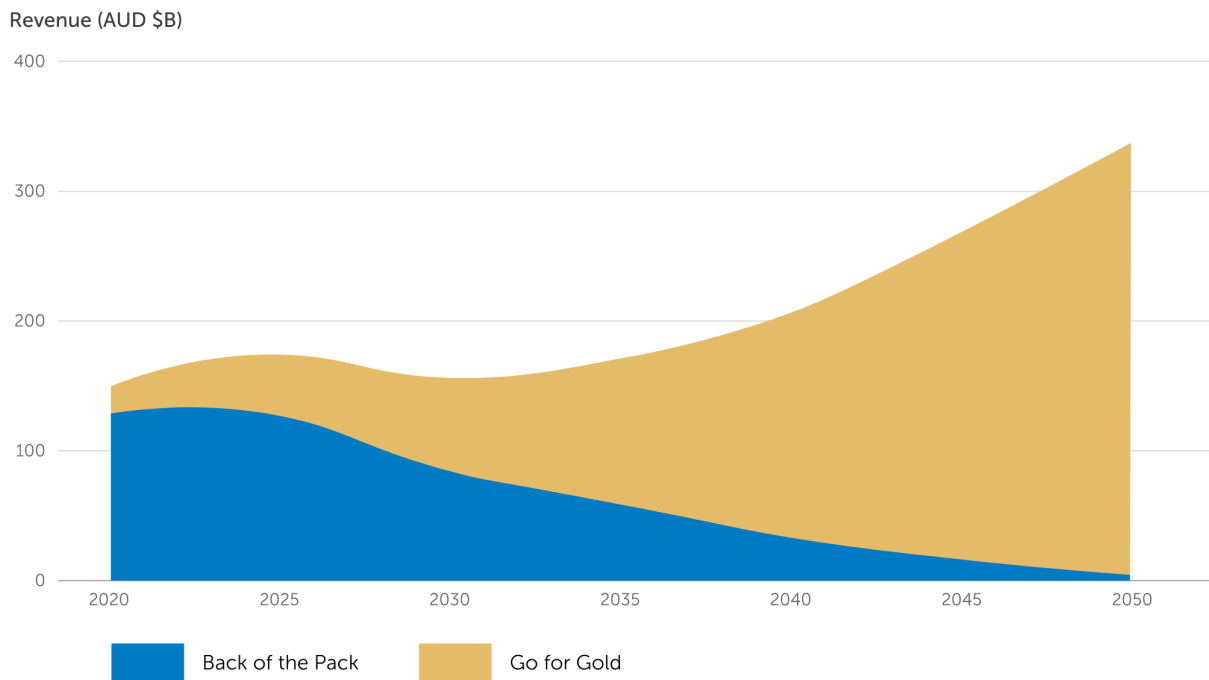
Work by Beyond Zero Emissions and leading economic analysts ACIL Allen shows that development of industries such as green steel and renewable hydrogen in the Hunter region of NSW and Gladstone region of Queensland can leverage over \$35 billion in capital investment, generate an additional \$13 billion in revenue by 2032, while creating over 40,000 new local jobs.<sup>151</sup> This case study of two industrial hubs is only a fraction of what can be mobilised through a national Go for Gold scenario.



However, to achieve this Australia needs to invest now to build the infrastructure and domestic capacity to sustainably produce, mine, refine, smelt and value add to existing and new export commodities. Ensuring onshore processing capacity capitalises on Australia’s rich and competitive renewable energy resources and enables higher value capture from exports.

If we invest early and set a clear vision for developing these zero-emissions exports, we can achieve an export revenue profile similar to Figure 8.

Figure 8: Projected export revenue profile under two scenarios



Under this ambitious vision for Australia, we avoid a ‘valley of death’ scenario due to strong early investment in zero-emissions export goods. Much of this can be accomplished through leveraging our strong cash flow from current investments to develop relatively low cost front end strategy, feasibility assessments and pilot projects for the future zero-emissions exports.

The private sector is already moving in this direction with recent activities targeted towards decarbonising our existing exports. This includes fuel switching in the mining sector (Fortescue Metals Group, BHP), renewable processing of critical minerals (BHP, Sun Metals) as well as moving alumina and aluminium towards firmed renewable energy (Rio Tinto, Alcoa, Tomago). At the same time, investment and planning for renewable hydrogen and green steel now will result in dividends by the 2030s as these technologies mature and scale to export volumes.<sup>152</sup>

Importantly, early investment across a portfolio of green exports allows these opportunities to be realised with minimal risk.

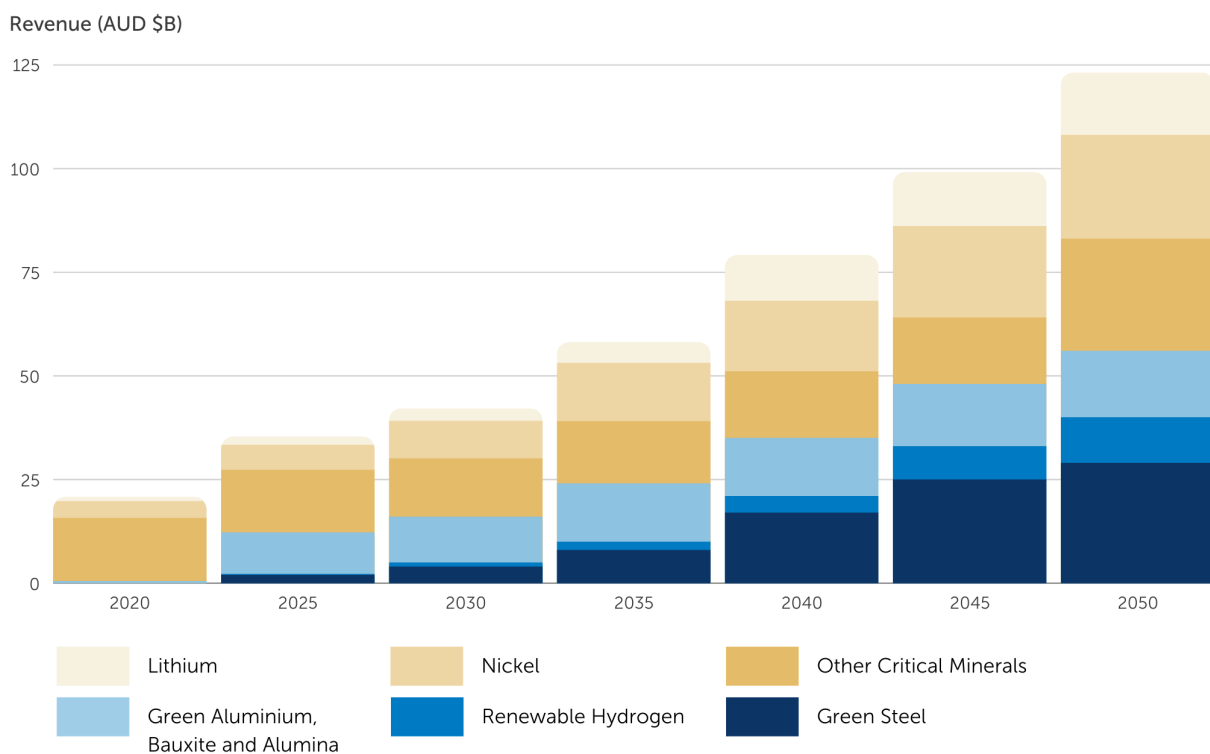
In the last 30 years, our export profile of coal, gas, iron ore, alumina and other resources have created tremendous wealth for Australians. Much of this was achieved through public/private partnerships with support through policy, incentives and infrastructure. It's time to apply this same recipe of success to a new generation of zero-emissions exports.

## Scenario: Slow Starter

If Australia takes a more cautious, slower industrial development strategy across the four classes of zero-emissions goods, growth will be drastically reduced

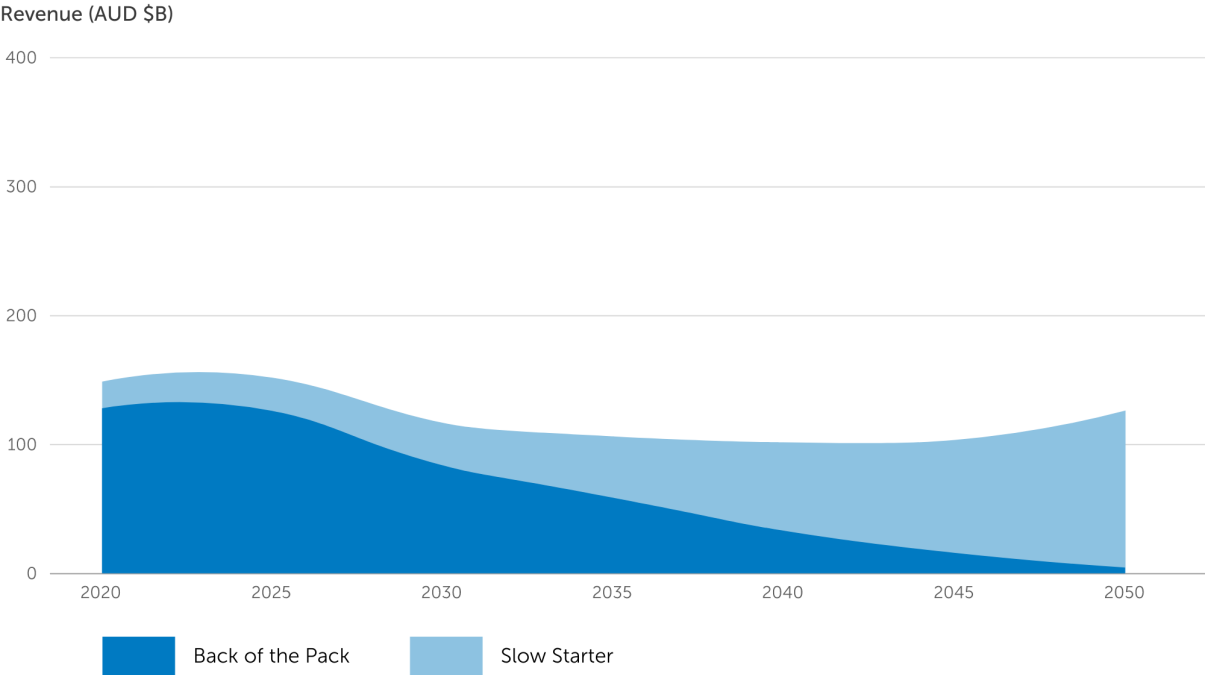
In this scenario we may still see export revenue from zero-emissions products increase steadily, from \$21 billion in 2020 to \$33 billion in 2030 and \$123 billion by 2050, but growth is effectively a third of the rate of the Go for Gold scenario.

Figure 9: Breakdown of zero-emissions product export revenue by product category in the Slow Starter scenario



Our model shows that in this scenario, Australia risks entering an export earning ‘valley of death’ from the mid-2020s with two decades of suppressed export earnings due to the likely rapid collapse in fossil fuel exports and a relatively sedate investment in growth areas. Additionally, the investment required will come at a time of reduced revenue from export earnings, increasing impacts of climate change, as well as billions of dollars of abandonment costs for our fossil fuel projects. Developing sufficient market share to achieve the economies of scale required to be internationally competitive will also be a serious challenge. The later we kick this investment into zero-emissions exports, the harder and riskier it will be.

Figure 10: Projected export revenue profile under two scenarios



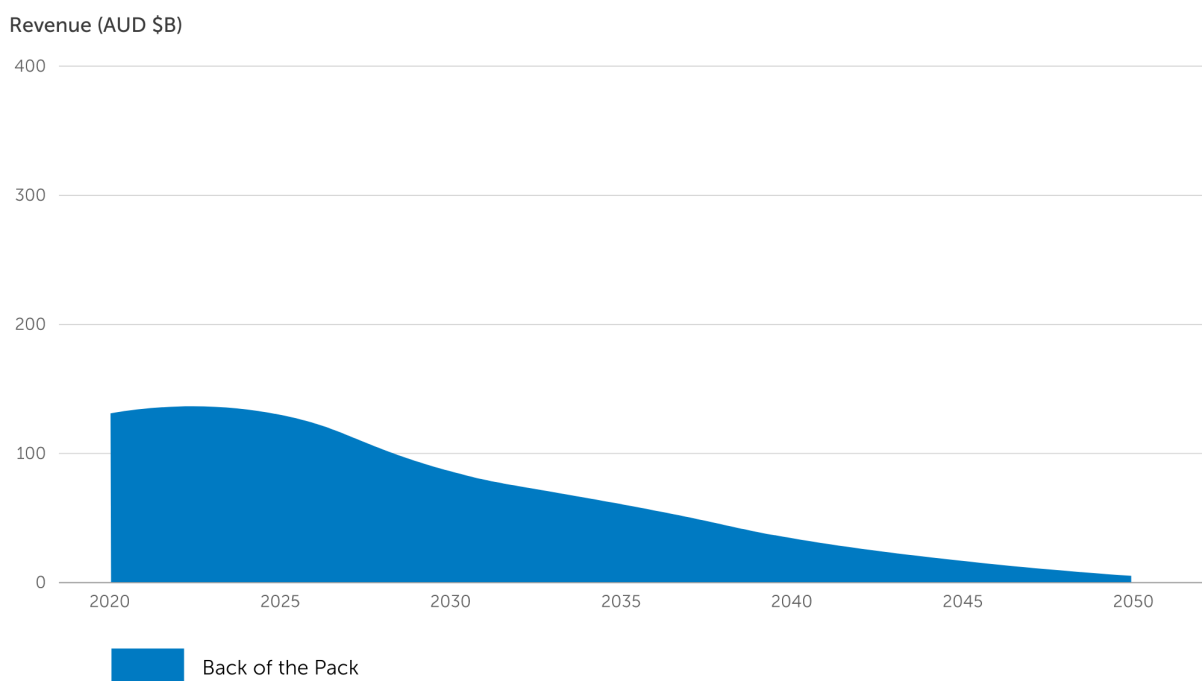
## Scenario: Back of the Pack

### Continuing to only invest in fossil fuels is a material risk to the economy

*The Business Imperative* chapter has already highlighted the risks of relying on fossil fuels to drive exports and economic growth. The market appetite for coal is ever decreasing and even gas exports are facing increasing international competition from cheaper, more flexible gas producers in Russia, US, and Mozambique, shrinking our global market share from 20% to 10% by 2040.<sup>153</sup>

Fossil fuels will not deliver long term economic prosperity.

Figure 11: Projected export revenue profile under the Back of the Pack scenario



Meanwhile as decarbonisation efforts accelerate, global investment in renewables and sustainability are booming.

The private sector may be able to capture some of this green export market share. However, without active government support it is unlikely the private sector will be able to effectively develop new industries on their own. With the scale of opportunity available, it is critical to recognise that Australia is competing for investment on a global scale where government support is critical to the choice of investment destinations at this level.

Without Australian governments playing an active role to help drive this diversification and develop zero-emissions industries, the nation risks losing investment opportunities as global capital gravitates towards more favourable jurisdictions.

Competing exporters such as Chile, Saudi Arabia, UAE and China are already forging ahead, keen to capture global market share and revenue. This includes:

- A \$5 billion renewable hydrogen/ammonia project in NEOM in Saudi Arabia, producing 650 tonnes of renewable hydrogen per day, beginning 2025<sup>154</sup>
- Emirates Global Aluminium in UAE securing a deal with BMW to buy 43 million tonnes of green aluminium<sup>155</sup>
- China's established dominance in the rare earths market<sup>156</sup>
- Chile's targets to have 5 GW of electrolysis capacity by 2025 attracting up to \$12 billion of investment interest<sup>157,158</sup>

International competition is growing and gathering momentum. We must not jeopardise our place in these future zero-emissions global supply chains with the Back of the Pack scenario.

### **Diversifying our local fossil fuel economies**

For decades, fossil fuels have powered the Australian economy. As Australia responds to shifting global demand towards zero-carbon products, communities that have traditionally depended on the fossil fuel industry will likewise adapt. A range of infrastructure, services and skills are common to both the fossil fuel industry and new industries servicing the zero-carbon economy. These include:

- Freight and port infrastructure
- An ecosystem of suppliers, trades and service industries, including the mining equipment, technology and services sector (METS)
- Oil and gas sectors can play a role developing renewable hydrogen
- Workers in the steel and aluminium/alumina industry will be experts on the ground to implement innovative zero-emissions processes
- The coal industry features many of the same skills and technical know-how useful for critical minerals mining and processing

Development of zero-emissions export industries can reinvigorate our industrial hubs, particularly those in regional Australia. The activities from developing renewable infrastructure, new facilities and innovations will bring jobs and investment from all around Australia and the world. With the right planning and policies in place, we can ensure that these new economic activities will deliver for local communities in a fair and equitable way.

In the short term, fossil fuel activities will likely continue in parallel to the development of zero-emissions industries and cash flow from those industries will support the economy as nascent industries mature. Nonetheless, planning for the inevitable shift to a zero-carbon economy and developing a clear diversification strategy must begin now to ensure our regions don't suffer. Early planning, consultation and goal setting will be key.

## Next Steps

Australia stands at a crossroads. Decarbonisation is gaining momentum as countries compete to build the infrastructure, skills and technologies to capture the new generation of zero-emissions goods.

With unparalleled access to cheap renewable energy and mineral resources, and local engineering know-how to deliver global scale new resource projects, Australia has an opportunity to thrive as a leading exporter of green materials, fuels and clean technologies.

The climb ahead is steep so we need to start now.

Our analysis shows if we present a strong vision and invest in zero-carbon commodities we can bring industry back to the regions, secure export earnings of \$72 billion by 2030 and \$333 billion by 2050, and create tens of thousands of quality and stable jobs in regional Australia.

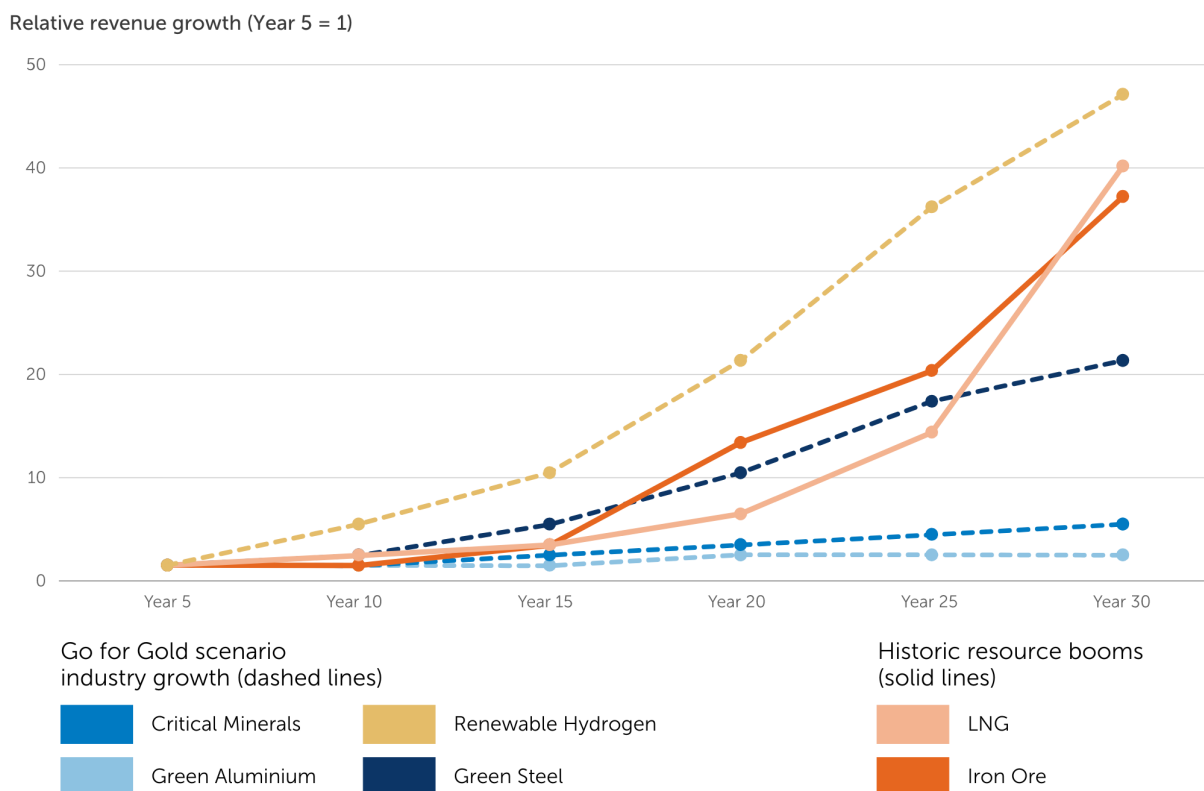
Australia has a strong track record in establishing major export industries at pace.

In the space of 20 years, Australian iron ore production increased over 500% from 174 million tonnes in 2000 to 919 million tonnes in 2019, roughly doubling every 10 years.

The development of coal seam gas is even more rapid, growing by almost 700% within 10 years (from 5,700 Mcm to almost 40,000 Mcm), now contributing to over a quarter of total natural gas production in 2020.<sup>160</sup>

When this historical growth of iron ore and LNG exports over the last 25 years is plotted and compared to our Go for Gold scenario, we see that not only is this growth trajectory possible, it is quite conservative for the majority of the export goods; Figure 12.

Figure 12: Go for Gold growth trajectory is comparable to historic resource booms



As with these past transformations, a coordinated national plan with supporting policies, infrastructure and initiatives to build industry ecosystems is critical in order to reap the benefits.

Despite our natural advantages, the realisation of this thriving zero-emissions export opportunity will not *simply happen*.

Australia is already in danger of being left behind by our competitors who are rapidly investing, innovating and growing their own green export industries. If we do not capitalise on our advantages, we will lose the race to retain key value chains onshore, remaining a nation that exports low value commodities, unable to capture their downstream value and missing out on the full economic benefits.

To an extent, Australian federal and state governments have recognised these opportunities and implemented supporting policies such as the Modern Manufacturing Strategy, the Hydrogen Roadmap, the Technology Investment Roadmap and the Net Zero Industry and Innovation Program. However, if we are to truly transform our industries and bring economic benefits to the wider community, a more coordinated and holistic approach will be needed.

Action is needed now to secure this economic opportunity for Australia. A price on carbon would send a strong market signal to accelerate the deployment of zero-emissions industries. Additionally, Australia must rapidly expand investment in the deployment of the technologies



needed to capture the massive opportunity from zero-emissions export goods. This requires a targeted strategy coupled with policy support and investment from all levels of government.

### Lighthouse projects illuminate the way

Australia has a clear advantage over global competition and the ambitious plans highlighted in Table 2 are prime examples of the opportunity at hand.

These lighthouse projects paint the picture of Australia as a green export powerhouse. However, these projects also require the support of a whole new industry ecosystem including renewable generation, infrastructure, new skills and training as well as strong international trade relationships.

**Table 2: The opportunity at hand**

Project	Description	Potential
Sun Cable <sup>162</sup>	High voltage transmission system to take solar from Northern Territory to Singapore	14 GW of solar 15% of Singapore’s electricity Beginning 2027
Fortescue Metals Group <sup>163,164</sup>	Ambitious plans to produce renewable hydrogen and green steel to the world	15 Mt of hydrogen by 2030 300 GW of zero-emissions energy Capture 10% of world’s steel market
Asian Renewable Energy Hub <sup>165</sup>	Wind and solar farm to generate renewable energy for Pilbara and exports	26 GW of renewables Renewable hydrogen and ammonia to begin exports 2027/28
Western Green Energy Hub <sup>166</sup>	Massive renewables to generate hydrogen and ammonia for heavy transport, ships & aviation	50 GW of renewables 3.5 Mt of hydrogen or 20 Mt of green ammonia

While mega projects may dominate news headlines, Australia is home to a range of innovators who are making the most of the zero-carbon opportunity at different scales. Established players include Molycop, Ampcontrol and Rinnai, while newer companies making waves include RayGen and MGA Thermal in energy storage, Diffuse Energy in wind generation, Energy Renaissance in battery manufacturing, Alpha HPA in sustainable high purity alumina, SwitchDin in smart energy management and 3ME and BME in the electrification of mining vehicles.

This is only the tip of the iceberg. Providing a pathway for Australia to become a green export powerhouse will not only unlock the four primary exports discussed, it will also catalyse flow-on investment and interest in adjacent zero-emissions technologies and sectors.

## A \$100 billion export target for zero-emissions goods

Setting an export target of \$100 billion for renewable hydrogen, green steel, green aluminium, and critical minerals by 2035 is an important first step.

This will sell our vision on the global stage, helping to build Australia's reputation as an attractive investment destination for developing zero-emissions goods. Moreover, it demonstrates our commitment to global decarbonisation efforts.

To cement that commitment Australian governments should provide policy support, including:

- Low-cost loans through Export Finance Australia and Clean Energy Finance Corporation to support and de-risk investments
- Accelerating the development of new innovative technologies that enable zero-emissions exports through bodies such as ARENA or Cooperative Research Centres (CRC)
- Improving carbon accounting standards to ensure compatibility with international markets
- Supporting industries through tax write-offs/incentives/subsidies, grants, matched funding and other budgetary mechanisms
- Local procurement policy to aid with early offtake and growth of local skills and manufacturing capability
- A strategy that outlines key milestones, goals and actions for achieving this target

## Lock in markets through trade partnerships

Governments should also pursue strong zero-emissions trade partnerships and lock in markets for Australian businesses.

This will be a vital step in aligning our export targets to the ambition of our key trading partners (Japan, South Korea, US, EU and China) and cement Australia's place in their decarbonised supply chain. For example, green steel and aluminium for European and Japanese car manufacturers, critical minerals for the battery industry of South Korea and the US, renewable hydrogen to power Japan and South Korea.

Bodies such as DFAT and Austrade should harness Australia's abundant renewables, resources and reputation of excellent ESG compliance as key advantages to help secure trade deals, investment interest and supply contracts for Australian industries.

## Establish a Supergrid Deployment Authority

To fully realise a zero-emissions exports portfolio, we will need to significantly expand our renewable energy generation, firming and grid infrastructure towards a world-leading supergrid.

Establishing a Supergrid Deployment Authority with a \$20 billion lending facility and a remit to undertake large scale investments in grid infrastructure is critical to underpin the growth forecast in the Go for Gold scenario.

The renewable energy needed to support our exports will require careful forward planning to ensure we have the necessary infrastructure and generation backbone to support our vision as a green export powerhouse. AEMO has already recognised some of this opportunity by including the “Hydrogen Superpower” scenario in its recent 2021 Inputs, Assumptions and Scenarios Report.<sup>167</sup> While this important work from AEMO should be used as a template, the final Australian Supergrid should go further in its ambition. For example:

- Account for energy demands (generation, storage, grid services etc.) to support the full spectrum of potential zero-emissions export goods, including green steel, green aluminium and critical minerals, in addition to hydrogen.
- Investigate the feasibility of linking national grids to activate new renewable energy zones, provide a more diverse generation profile and alleviate demand for grid storage capacity. This is becoming increasingly relevant as long distance HVDC transmission becomes more prevalent around the world.
- More comprehensively incorporate the potential of offshore wind. More than 10 offshore wind projects totaling 25 GW have already been proposed with a capacity for many more.<sup>168</sup>

## Establish Renewable Energy Industrial Precincts

A national rollout of Renewable Energy Industrial Precincts will help build the critical industry ecosystem needed to support our zero-emissions export targets.

These regions and clusters of manufacturers, driven by renewables, will help set a clear vision for our industrial heartlands for the growth of entire zero-emissions industry ecosystems. This allows them to leverage the benefits of co-location, shared infrastructure and a concentrated skilled workforce to produce world-class export goods in addition to a whole range of local industry products, services, innovations and collaborations.

Our work developing Renewable Energy Industrial Precincts in the Hunter and Gladstone regions has gained tremendous local support, highlighting the keen interest in our regional manufacturing heartlands for growing zero-emissions industries. Our research shows that establishing zero-emissions industries there can create over 45,000 jobs and generate over \$13 billion in revenue.<sup>169</sup>

## Harness investment

Investors, in combination with government bodies, can also play a key role in mobilising capital towards building the Go for Gold scenario.

Key steps include increasing expectations from shareholders and regulators for the disclosure of adequate climate risk management and carbon accounting from companies. This will help ensure fiduciary duty that's in line with global expectations as well as making sure climate risks and opportunities are being properly valued. Investors should also look to expand investment strategies and capital allocation towards a more equitable and decarbonised world.<sup>170</sup>

## Leverage industry groups and unions

Industry groups and unions should be leveraged for their ability to coordinate wide-scale action for transformation and diversification towards the green export opportunities.

Many industry groups have already called for actions to decarbonise in combination with solutions on how to help their stakeholders and members make the most of these opportunities. These include the Australian Industry Group, the Business Council of Australia, the Australian Steel Institute, the Australian Aluminium Council, the Australian Hydrogen Council and the Minerals Council of Australia.

Unions are another powerful group that can help unlock these new export goods, accelerating the transition of workers and their skill sets towards long term, sustainable jobs while building key onshore capabilities.

## Collaboration is key

To effectively capture these export opportunities, collaboration between industry, government, investors, communities and other stakeholders is crucial.

Collaboration not only reduces risk for all parties, it fosters synergies and relationships that can accelerate deployment and rapid scaling. For example:

- Pairing heavy-industry users with renewable developers and transmission planners to match supply, demand and infrastructure requirements
- Harnessing the technical knowhow of fossil fuel industries to help accelerate the newer zero-emissions industries, for example, fossil gas to renewable hydrogen, coal and fossil mining equipment, technology and services (METS) to critical minerals and renewable METS solutions
- Aligning investors, developers, governments, communities and industries towards large scale regional zero-emissions developments like Renewable Energy Industrial Precincts
- Accelerating investment and development with smart policy, community backing and industry support

# Acknowledgements

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**This report was published by Beyond Zero Emissions Inc.**

**First published September 2021**

Beyond Zero Emissions Inc. is a registered charity, based in Victoria with a national outlook. Beyond Zero Emissions is listed on the Commonwealth's Register of Environmental Organisations ('Beyond Zero Emissions Fund'), which allows organisations to be endorsed as Deductible Gift Recipients by the Australian Taxation Office.

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### **Recognition of traditional custodians**

We recognise that the sovereignty of Aboriginal and Torres Strait Islander peoples over their land was never ceded and the impact of this ongoing dispossession continues to this day.

Beyond Zero Emissions stands in solidarity with First Nations people in calling for the establishment of a First Nations Voice in the Constitution, as described in the Uluru Statement from the Heart.

We further support calls for the establishment of a Makarrata Commission on agreement-making and truth-telling between Aboriginal and Torres Strait Islander peoples and governments.

Beyond Zero Emissions maintains an office in Melbourne on the traditional lands of the Wurundjeri-willam people of the Kulin Nation, and in Newcastle on the lands of the Awabakal and Worimi peoples. We pay our respects to all First Nations Elders past, present and future.

## Appendix: Modelling Assumptions

Modelling is based on projections from organisations such as the International Energy Agency (IEA), The Grattan Institute, the Department of Industry, Science, Energy and Resources (DISER) and industry sources. More detailed information is provided below.

### Critical minerals

Our candidates for critical minerals in this modeling are taken from the Resources Technology and Critical Minerals Processing roadmap from the Modern Manufacturing Strategy<sup>171</sup> (cobalt, graphite, lithium, rare earths, titanium, vanadium, nickel) as well as a selection of important clean-tech minerals that are currently exported from Australia (copper, manganese and zinc). These minerals are vital for key growth markets such as energy storage, electric vehicles and electrification.

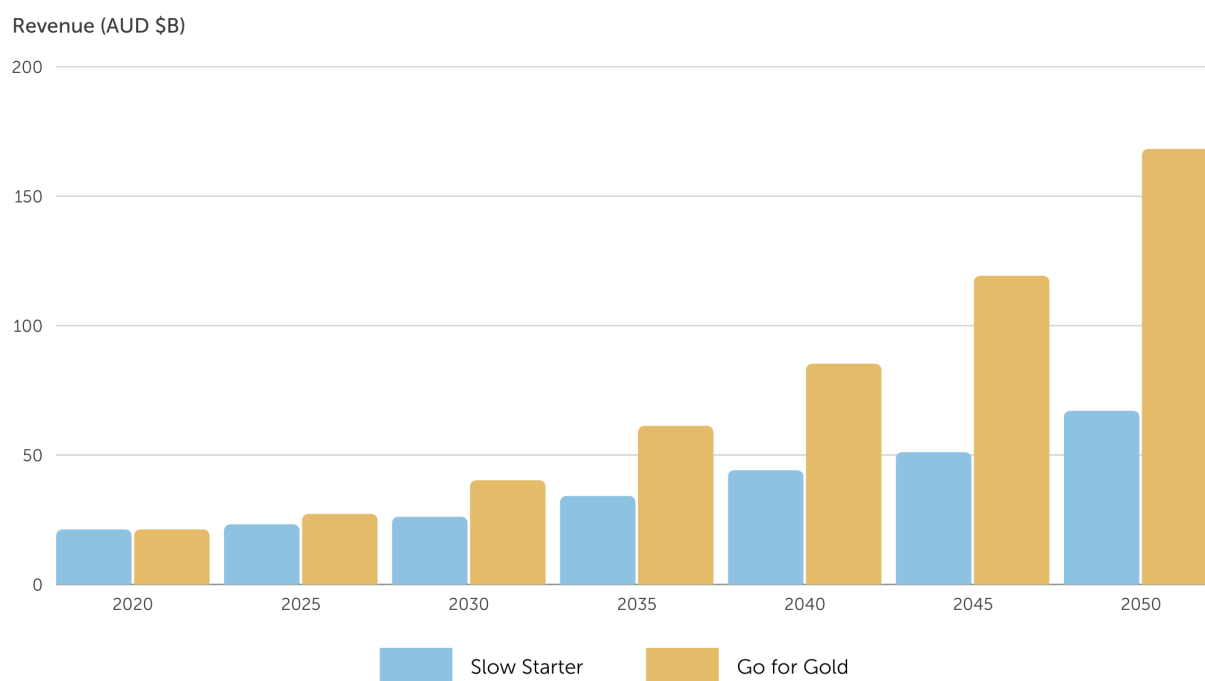
#### Slow Starter

A conservative approach is taken for modeling critical minerals in the Slow Starter scenario with growth based on the IEA's Stated Policy Scenario (STEPS). This is less ambitious than the world's shared sustainability goals and the ambition of our key trading partners (who have mainly set a target of net zero by 2050).<sup>172</sup> In this model, Australia has a revenue of \$67 billion from critical minerals by 2050, but this is \$100 billion less than our potential in the Go for Gold scenario.

#### Go for Gold

In this scenario, critical minerals have a combined potential revenue of \$168 billion by 2050. As a starting point, we updated the demand to reflect the mineral requirements for a "well below 2°C global temperature rise" scenario or the Sustainable Development Scenario (SDS) from IEA.<sup>173</sup> This is a higher growth rate than the STEPS used in the Slow Starter scenario and better reflects the trajectory of global markets as climate policies continue to accelerate and grow in ambition.<sup>174</sup> The growth in revenue also reflects increased onshore processing, value adding to our raw materials and capturing more of the downstream wealth for our communities.

Figure 13: Comparing the revenue from critical minerals of two scenarios



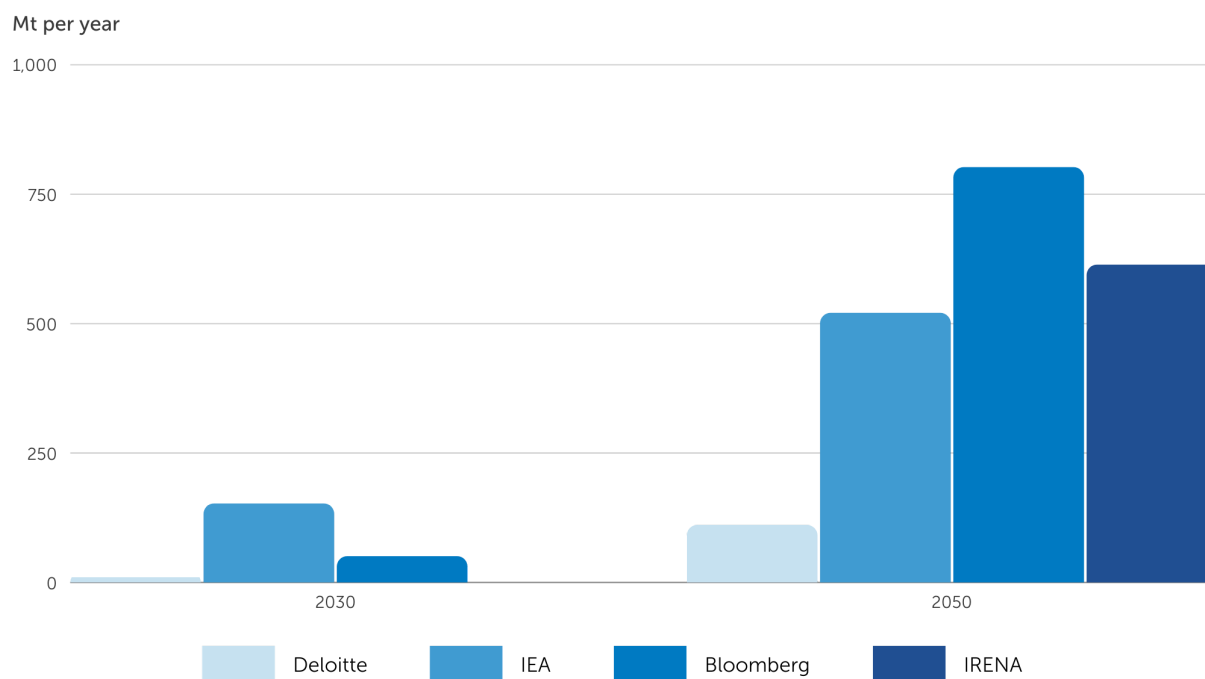
## Renewable hydrogen

### Slow Starter

In the Slow Starter scenario, renewable hydrogen contributes \$11 billion by 2050 and is based on the *Targeted Deployment* analysis from Deloitte.<sup>175</sup> This number is also commonly referenced by the Australian Government.<sup>96,191</sup> However, many of the modelled outputs have already been superseded since the report's release in 2019. For example, the original modelled global hydrogen production of < 5 Mt by 2030 has already been overtaken by targets from Japan (10 Mt),<sup>176</sup> EU (10 Mt)<sup>177</sup> and Fortescue (15 Mt)<sup>178</sup> alone. This underestimation is further highlighted by comparison with more updated modelling from IEA,<sup>179</sup> Bloomberg<sup>180</sup> and IRENA<sup>181</sup> (Figure 14).



Figure 14: Comparing the modelled hydrogen production at 2030 and 2050

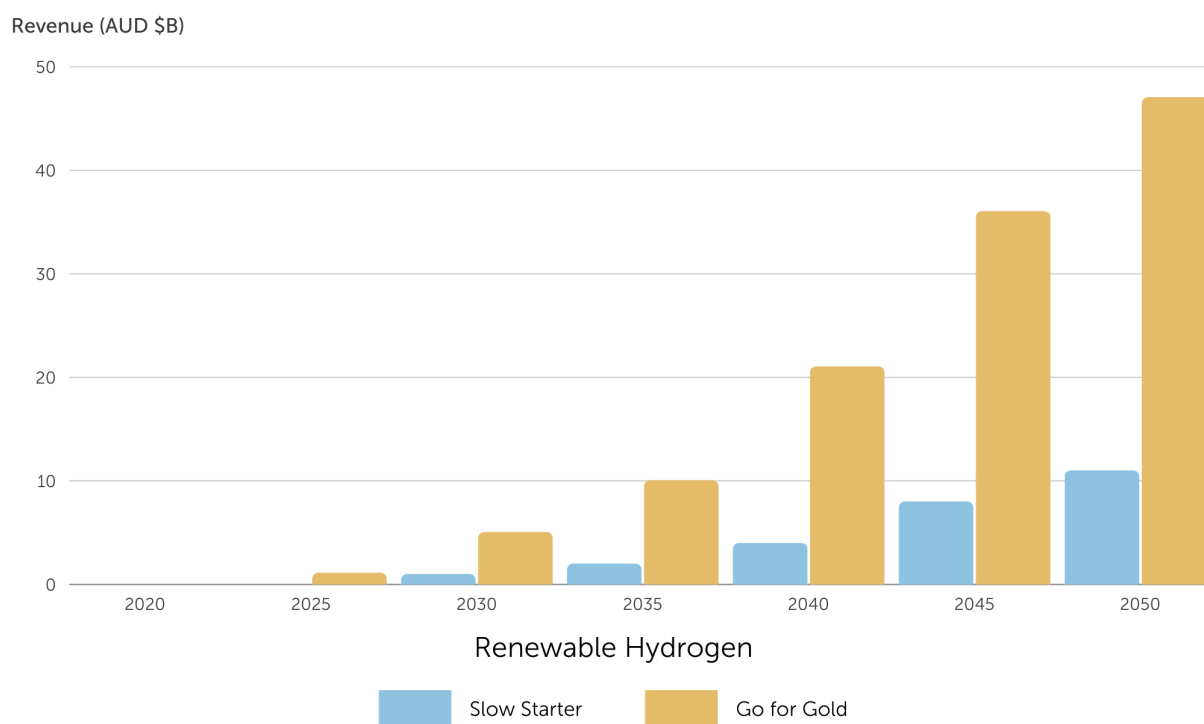


In addition, Strategy& estimates that the green hydrogen export market could be worth AU\$420 billion by 2050.<sup>182</sup> These factors demonstrate confidence that the value of \$11 billion (or less than 3% of the export market) represents a conservative estimate of Australia's potential export share, especially when compared to our current 22% of gas and 20% of thermal coal exports.<sup>183</sup>

### Go for Gold

The Go for Gold scenario uses the more up-to-date low-carbon hydrogen market size from IEA<sup>184</sup> and we see our hydrogen exports increase to a value of \$47 billion or around 11% of the export market. If given the opportunity, this can be substantially higher given that Australia is a high potential exporter, only slightly behind Gulf countries such as Saudi Arabia and ahead of export competitors like Canada, Chile and Argentina.<sup>185</sup>

Figure 15: Comparing the revenue from renewable hydrogen of two scenarios



## Green steel

### Slow Starter

Green steel accounts for \$29 billion worth of exports by 2050 in the Slow Starter scenario or 3.5% of the global steel market. This is a conservative estimate based on the Grattan Institute’s analysis,<sup>186</sup> roughly half their figure of \$65 billion.

From the Grattan Institute, *Start with Steel*, 2020

*“This scenario relies on Australia producing almost 7 per cent of the world’s steel, a significant increase on the 0.3 per cent it produces today. But this market share is not unrealistic.*

*Australia’s rich bauxite and fossil fuel resources enable it to manufacture about 15 per cent of the world’s alumina today. And Australia’s share of world bauxite production (27 per cent) is comparable to, but lower than, its share of iron ore production (38 per cent).”*

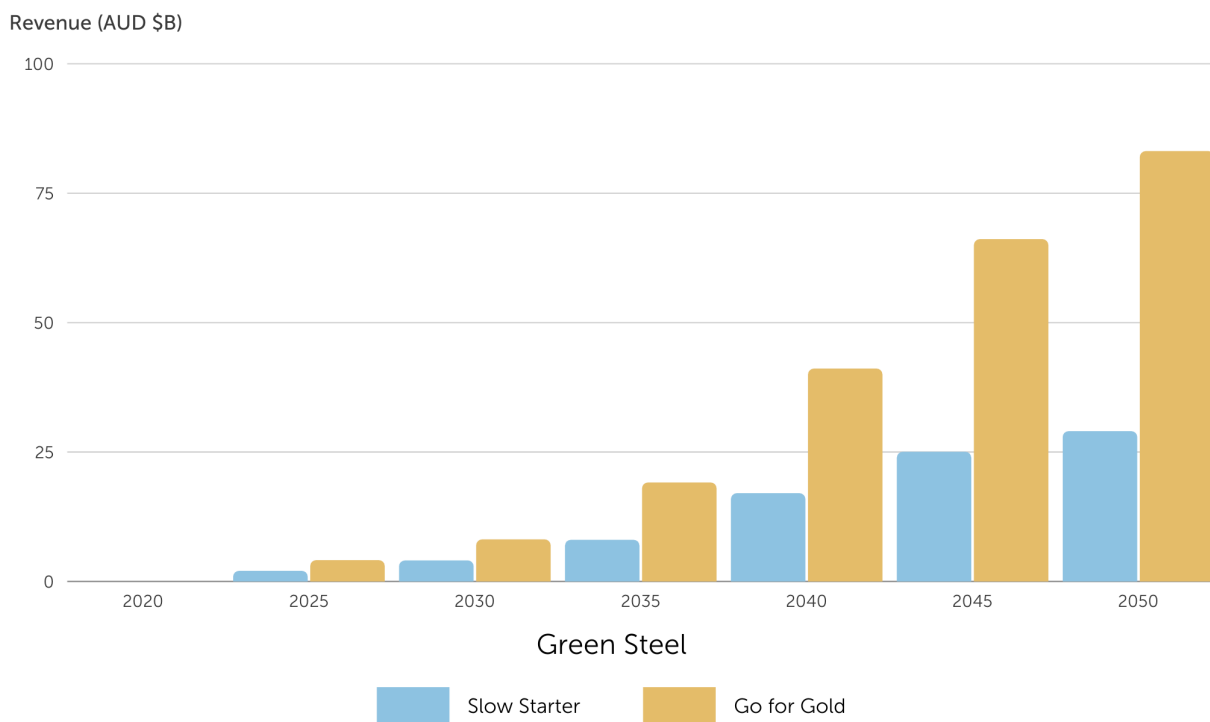
*“Significant investment – almost \$200 billion in today’s dollars – would be required for Australia to produce almost 7 per cent of the world’s steel. This amount of investment is large, but is much less than the \$350 billion invested in Australia by the oil and gas industry in the past decade alone. In the same way, building a green steel industry would require significant investment by international steel companies.”*

## Go for Gold

For the Go for Gold scenario, the green steel market is updated to better reflect the projections from the Grattan Institute's *Start with Steel* report and assumes a modest increase in market share (from 7% to 10% by 2050) due to Australian green steel capturing some of the European market from carbon heavy producers such as Turkey, Russia and China. This leads to a potential revenue of \$83 billion in 2050. It also aligns with the ambitions of Australian leaders such as Fortescue Metals Group who have flagged the potential to capture 10% of the global steel market, creating 40,000 jobs.<sup>187</sup>

This case is further reinforced with the recent announcement of carbon border adjustment mechanisms from the EU. Rather than heralding a death sentence for our industries, we should invest to rapidly decarbonise and turn carbon border adjustment mechanisms into a market opportunity, outcompeting countries less willing or able to move towards zero emissions.

Figure 16: Comparing the revenue from green steel of two scenarios



## Green aluminium

### Slow Starter

Our estimates in the Slow Starter scenario for green aluminium is \$16 billion by 2050 and incorporate revenue from primary aluminium, bauxite and alumina. We have extrapolated growth

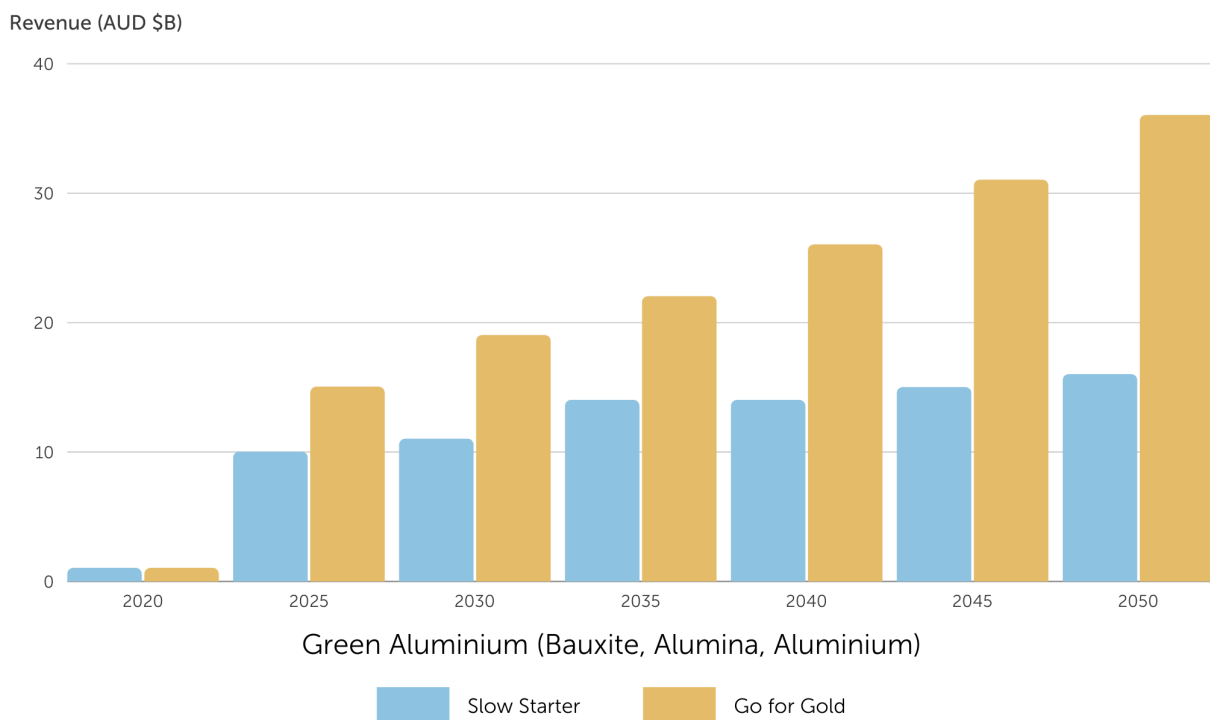
rates based on the *Resources and Energy Quarterly March 2021*, which forecasts export revenue from bauxite and alumina to have a CAGR of 0.6% and 0.8% respectively over the years 2021-22 to 2025-26. These estimates are conservative but based on government projections. This reflects an Australian aluminium industry that transitions to renewables but more or less maintains its current size.

The Grattan Institute estimates the worldwide green aluminium and alumina market to be approximately \$340 billion in 2050, so the projected \$16 billion would represent a 5% market share<sup>188</sup> and a decrease from our current market share of 10-12%.<sup>189</sup>

### Go for Gold

In the Go for Gold scenario, we expect a small increase in market share from Australian green aluminium, alumina and bauxite, primarily due to its green credentials helping to secure Australian supplier’s place in the global supply chain. This is particularly true for the upstream materials of bauxite and alumina where we are the world’s top producer and exporter.<sup>190</sup> The projected green aluminium revenue of \$36 billion in 2050 is also on par with our current market share.

Figure 17: Comparing the revenue from green aluminium of two scenarios



To note, our modelling of Australia’s green aluminium opportunity is slightly constrained by the need for firmed renewable energy to the aluminium smelters. As such, the majority of the

projected revenue opportunities are in the upstream green bauxite and green alumina products. However, if we are able to increase the firming capabilities of our grid, we would be able to greatly increase the revenue stream by capturing more of the higher value green aluminium market. This can be done through a combination of grid storage expansion, diversification of renewable generation sources and low cost hydrogen for grid firming.

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