



CLIMATE ENERGY FINANCE

A VALUE-ADDED CRITICAL MINERALS BILATERAL AGREEMENT FOR AUSTRALIA AND SOUTH KOREA

Australia's imperative to create a mutually-beneficial bilateral agreement with South Korea, leveraging the US Inflation Reduction Act to complement Korea's battery industry and value-add onshore.

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Key Recommendations

Climate Energy Finance recommends that the Australian Government act on the following imperatives to grasp Australia's once in a century opportunity to lead in energy transition materials, leveraging synergies with South Korea's battery value chain to access the ~US\$800bn pool of decarbonisation capital under the US Inflation Reduction Act (IRA):

Initiate ambitious critical minerals bilateral investment and trade discussions with South Korea with a view to formalising an Australia-South Korea Compact. These negotiations should aim to build a joint trade and investment policy response to the US IRA that best accelerates joint investment into high-value battery manufacturing initiatives, builds critical mineral supply chains, and deploys the latest available technologies in clean energy generation and embodied decarbonisation.

Commit to a focused, sizable and urgent Australian domestic response to the IRA, in the form of a \$100bn investment of strategic national interest public capital to crowd-in \$200-300bn of private investment and seize Australia's renewables investment, employment and value-added export opportunities. This should be funded by the Australian government's established nation-building and energy transition finance instrumentalities including the Clean Energy Finance Corporation (CEFC), the Future Fund, the Australian Renewable Energy Agency (ARENA), Export Finance Australia (EFA) and the Northern Australia Infrastructure Facility (NAIF).

Allocate capital to enhancing and scaling Renewable Energy Industrial Precincts (REIPs) – dedicated clusters for new industry manufacturing and export, on a path to be powered by 100% renewables – to catalyse downstream investment through public-private international partnerships. Collaboration with South Korea into these regional export hubs across Australia enhances both nations' global position across the battery value chain, leveraging their synergies and expertise across mining, minerals processing and material manufacturing.

Establish globally competitive battery stationary storage manufacturing capability onshore through partnership with South Korea, integrating mine-to-battery supply to produce grid-scale energy storage solutions. South Korean firms are rapidly seeking to diversify their battery industry from electrified transport to stationary storage, and with a 26% share, South Korea is the second-largest global battery manufacturer after China. Establishing battery hubs in Australian REIPs provides a pathway for Korean firms to scale stationary storage and heavy haulage mine equipment EV capacity onshore to provide global supply chain diversification from China's dominant industry, whilst catalysing Australia's downstream industry.

The expansion of bilateral investment will unlock significant public and private capital from Korea into onshoring value-added projects in Australia, and expand the scope of collaboration between the two nations for future trade and co-investment in emerging electrified transport and stationary storage markets across India and the Indo-Pacific.

Executive Summary

Australia's Critical Minerals Strategy

Australia has the potential to secure its position as a world leader in the value-added critical minerals underpinning the energy transition. On 20 June 2023, the Australian Critical Minerals Strategy 2023-2030 was released, a framework to grow Australia's critical mineral sector by establishing value onshore, leveraging renewable energy and creating diverse sustainable supply chains through strong international partnerships.¹

The Government has earmarked \$500m to NAIF to support projects that align with the strategy on scaling downstream processing. The Albanese government inherited the Morrison government's \$2bn critical minerals facility, with \$1.5bn already committed. The May Federal budget added only \$57m over 4-years to 'foster international critical minerals partnerships' and a further \$23m on critical minerals policy development.

The Critical Minerals Strategy is a missed opportunity. The sector will be disappointed with the strategy's lack of ambition, falling well short of proposals put forward by industry leaders.² We needed a bolder scope, scale and speed, a nation-building vision to leverage Australia's world leading opportunity and respond with scale and ambition to global initiatives like the ~\$800bn IRA. The new funding commitment of \$500m for NAIF is a tiny fraction of the \$100bn of strategic, national interest public capital CEF estimates is required to crowd in \$200-300bn of private capital to seize Australia's once in a century opportunity to position itself as a value-added critical minerals and cleantech superpower.

A positive outcome of the strategy is the attention on leveraging foreign investment and export diversification through co-investment between financing agencies to establish joint ventures. Resource Minister Madeleine King acknowledges the importance of international strategy cooperation in developing and value-adding our critical minerals at speed and scale. This approach – the imperative of building partnerships in critical mineral value chains with our key trade allies – is a key impetus of this report.

An Australian-South Korea Compact to jointly leverage the brilliant opportunities being opened by the US Inflation Reduction Act (IRA) should be a key strategic priority given the two nations' complementary synergies, capabilities and skills sets.

The Australia-US Compact, US Inflation Reduction Act, and QUAD trade MoC

Securing diversified and resilient clean-energy technology (cleantech) value chains is of paramount importance to access global markets and leading technologies and engineering skills as the world transitions to decarbonised economies. Governments worldwide are seeking to 'friend-shore' cleantech material processing and manufacturing capacity to safeguard domestic energy and electrified mobility markets against supply chain disruption, material price hyperinflation and unsustainable practice.

On 20 May 2023, Australia and the US strengthened their partnership with the **Climate, Critical Minerals and Clean Energy Transformation Compact** (Compact).³ The bilateral

¹ Australian Government, [Critical Minerals Strategy 2023-2030](#), 20 June 2023

² The Australian, [New Critical Minerals Strategy to Disappoint Industry Hoping for Bold Plan](#), 20 June 2023

³ Aus Gov, [Australia-US Climate, Critical Minerals and Clean Energy Transformation Compact](#), 20 May 2023

agreement positions climate technology and clean energy as central pillars for Australian and US cooperation. Australia's Department of Climate Change, Energy, Environment and Water (DCCEEW) and US National Security Council will form the Clean Energy Industrial Transformation forum to establish the framework for the development, expansion and diversification of clean energy and critical mineral value chains across the Pacific.

At the same time the QUAD (US, Australia, Japan and India) strengthened their commitment to facilitating trade across the Indo-Pacific, establishing a Memorandum of Cooperation (MoC) between the respective export credit agencies to further promote trade, financing of trade-enabling projects, knowledge and expertise in clean energy power generation and distribution, and critical minerals.⁴ This complements the emphasis on export credit agencies in the Compact, leveraging the financial power of the US Export-Import Bank (US EXIM) and EFA to de-risk and scale new investment and deployment of cleantech and accelerate the shift away from our crippling dependence on high-emission, inflationary fossil fuel imports.⁵

The Compact will crowd-in an influx of private capital to cleantech and create opportunities to leverage and mobilise the significant financial support of the landmark US IRA of August 2022 and the Defense Production Act. Australia will be considered a domestic supplier under the Defense Production Act, allowing US state capital to underwrite Australian critical mineral projects, processing and potentially value-adding onshore.⁶

The IRA has transformed the global cleantech investment landscape, mobilising some US\$800bn in subsidies and capital incentives, together with the Department of Energy's Loan Program and the Defense Production Act. Significant supply and demand stimulus has provided a push-pull mechanism that has crowded in billions of private capital across electrified transport, renewable energy generation and battery storage.⁷

Since the IRA was introduced, a domestic investment pipeline of US\$50bn into batteries and US\$2.8bn into EV charging infrastructure has been announced.⁸

Opportunities for Australia-Korea partnership

The Compact and IRA clearly demonstrate that an accelerating global decarbonisation technology and investment race is well underway. Whilst China has a decade's head start on the rest of the world, the US is seeking to crowd-in cleantech supply chain investment and capacity from allied countries, such as Korea and Australia, with which it has free-trade agreements, as nations the world over seek to leverage the +US\$800bn stimulus.

This provides an enormous value-added trade opportunity for Australia. South Korea has much of the manufacturing capacity and expertise in place for battery and EV production, and Australia has a strong history of working constructively with Korea, as well some of the world's best reserves of critical minerals, and abundance of renewables to power onshore processing of energy transition materials.

To supply downstream battery facilities in the US, the South Korean government and manufacturers have already invested significant capital to scale onshore cathode production

⁴ Whitehouse, [QUAD Leader's Summit Fact Sheet](#), 20 May 2023

⁵ CEF, [Landmark AUS-US Climate, Minerals and Clean Energy Transformation Compact](#), 21 May 2023

⁶ The Saturday Paper, [Pentagon to Secure Australian Minerals in Green Deal](#), 27 May 2023

⁷ CEF, [The Inflation Reduction Act is Spurring a Tsunami of Inbound US Investment](#), 10 December 2022

⁸ Bloomberg, [How the World is Spending \\$1.1 Trillion on Climate Technology](#), 24 April 2023

and minerals processing in Korea. In April 2023, the government announced a joint investment pipeline with South Korea's dominant battery manufacturers of KRW 20 trillion (US\$15bn) in lithium battery technology and capacity advancements to 2030.⁹ In the US, South Korean firms LG Energy Solutions, Samsung SDI and SK On have led the charge into battery manufacturing. The South Korean government will provide an enabling US\$5.3bn in financial support to battery manufacturers seeking to scale their infrastructure across the North American supply chain.¹⁰

Australia, too, is perfectly positioned to supply the US under the new Compact, and to diversify South Korea's critical mineral value chains. In 2022, South Korea imported 79% of its battery precursor needs, 90% of this from China. To leverage the subsidy and tax credit programs of the IRA, diversification of value chains away from regions that pose geopolitical risks to the US has become of paramount importance to South Korea.

South Korea is a key trade partner with Australia, third behind China and Japan. Since the Korea-Australia Free Trade Agreement (KAFTA) was implemented in 2014, relationships, investment and collaboration between the respective economies has grown significantly. The battery value chain opportunity should leverage Australia's global credentials in mining capacity, our critical mineral resource base, and world scale, low-cost renewable energy to power onshore refining of energy transition materials pre-export. Australia should export "embodied decarbonisation"¹¹ and providing supply chain diversity for South Korea.

Australia must now, as a key strategic priority, work constructively with South Korea to ensure both economies are dealt into the North American value-added cleantech opportunity, and to leverage our combined world-leading capacity and skill sets.

In this report, CEF outlines how the strengthening of Australian and South Korean bilateral agreements across value-added critical mineral industries, and scaling of the capacity and cooperation of our export credit agencies, can bring material gain to both economies as we seek to integrate further into the global value chain, including in the US.

Harnessing Australia's world-leading expertise in mining and mineral extraction / processing and renewable energy resources, and leveraging Korea's world-leading battery IP and technology, there is potential to become a joint powerhouse in the global battery midstream market, capitalising on the generational opportunity of the IRA.

Like the massive opportunities for Australia-Korea collaboration across mining to battery and EV manufacturing, Australia also needs to think more strategically about the importance of greater opportunities across India and the Indo-Pacific. India's economy is undergoing sustained strong economic growth, with potential to be one of the largest EV markets globally, there is clear strategic opportunity for far greater Australia-India trade, investment and alignment across critical minerals and cleantech manufacturing, particularly with growing climate-energy-defence alignments of the US-Japan-India-Australia QUAD alliance.

⁹ Reuters, South Korea Announces \$15bn Investment in Advanced Battery Technologies, 20 April 2023

¹⁰ Reuters, [South Korea to Offer \\$5.3bn in Financing to Battery Investment in North America](#), 7 April 2023

¹¹ Embodied decarbonisation refers to processing and manufacture of energy transition materials onshore pre-export using renewable energy.

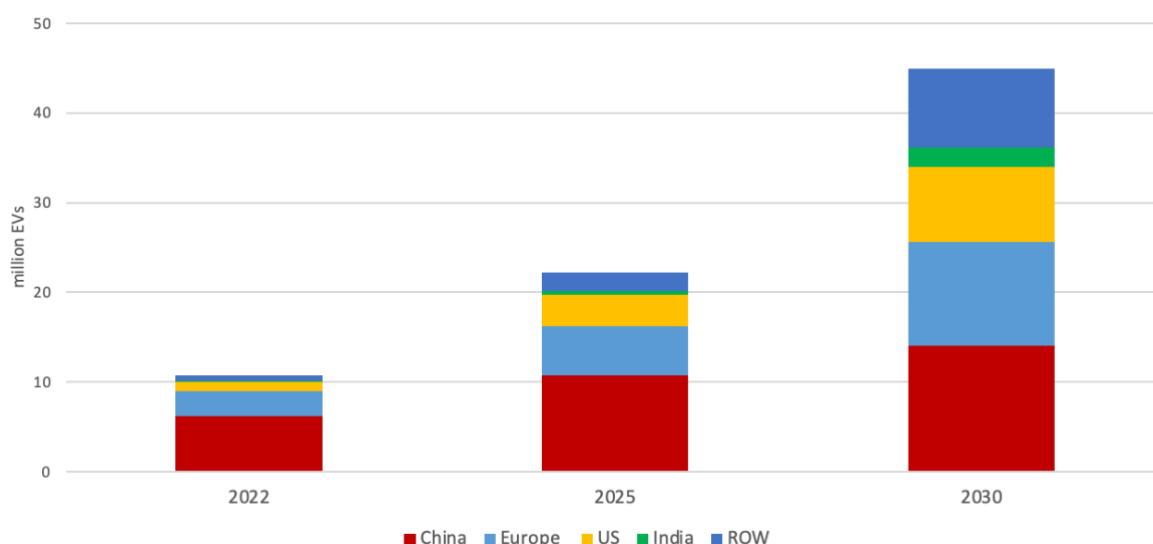
Section 1. The Global Growth of EVs and Battery Manufacturing

The EV market saw investments of US\$466bn in 2022, +54% yoy, dominated by China. Strong growth is set to continue to 2030 and beyond as EVs grow to dominate the global automotive market, reaching EV sales of 45m pa by 2030, a CAGR of 20%. To fuel the EV transition, lithium-ion battery capacity is set to grow from 1.57TWh to 6.79TWh by 2030.

In 2022, over US\$1.1 trillion was spent on climate technology globally.¹² Electrified transport was one of the fastest growing markets, up 54% in 2022 to US\$466bn.¹³ Electrified transport contributed 42% of cleantech investments, second only to renewable energy at US\$495bn.

83% of electrified transport investments were into passenger electric vehicles (EVs),¹⁴ with sales exceeding 10.6 million units in 2022, over 55% higher than new EV registrations in 2021.¹⁵ The rapid growth to 10 million sales means global new EV registrations exceeded the total auto-sales market of the European Union (EU). Under IEA's Announced Pledges Scenario (APS), global EV sales are forecast to reach 22.2 million by 2025 and 45 million pa by 2030.

Figure: Global EV Sales 2022 with 2025 and 2030 Forecast



Source: IEA Global EV Outlook 2023, CEF Calculations

Note: Forecasts under Announced Pledges Scenario

China is the global leader, with 87% annual growth in EV supply chain expenditure in 2022 to US\$234bn, contributing half the global spend. China accounted for ~60% of global EV sales in 2022. Under IEA's APS, China is forecast to have a global EV market share of 48% in 2025. In comparison, despite impressive annual growth of 57% in 2022, the US invested US\$57bn into electrified transport in 2022, less than a quarter of China.¹⁶ Although China will remain the

¹² Bloomberg, [How the World is Spending \\$1.1 Trillion on Climate Technology](#), 24 April 2023

¹³ BloombergNEF, [Electrified Transport Spending Soars – Transition Rolls On](#), 13 February 2023

¹⁴ Includes both Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs)

¹⁵ IEA, [Global EV Outlook 2023](#), 26 April 2023

¹⁶ BloombergNEF, [Electrified Transport Spending Soars – Transition Rolls On](#), 13 February 2023

dominant manufacturer of EVs and their value chain components, the US is expected to grow EV sales by 740% from 2022 to 2030 under IEA’s APS.¹⁷

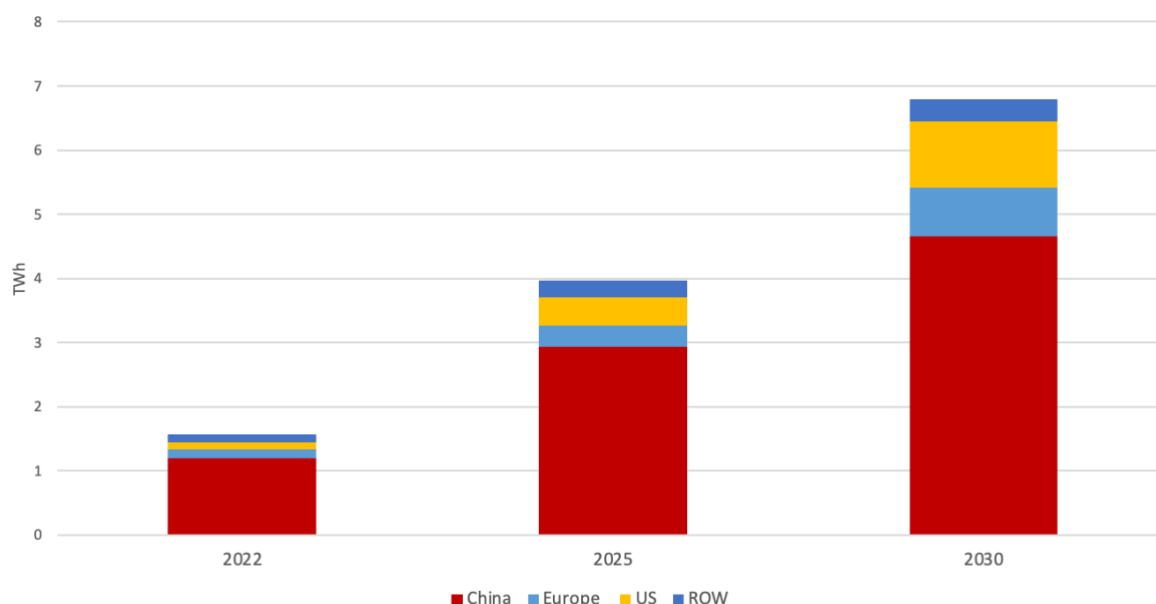
Nickel-rich cathodes (NMC and NCA) in EV batteries remained the dominant chemistry in 2022, accounting for ~68% of total demand in electrified transport. Alternative chemistries, such as LFP (lithium iron-phosphate) rose in popularity in 2022. However, 85% of all LFP EVs manufactured in 2022 were in China, with BYD alone supplying 50%.¹⁸ Only 3% of EVs produced in the US were with LFP chemistries.

Sodium-ion (Na-ion) batteries have emerged as an alternative to lithium-ion, given their current price competitiveness, being on average, 30% cheaper than LFP chemistries. However, they have a significantly lower energy density, between 75-160Wh/kg compared to 120-260Wh/kg for LFPs. High-nickel chemistries remain superior in energy density, and thus remain the priority chemistry for long-range, high-energy electric vehicles. Na-ion installed capacity was ~100GWh in 2022, centralised almost entirely to China. For context, the Li-ion market had an installed capacity of 1,570GWh globally in 2022.

Lithium-ion batteries remain the largest market and the dominant growth market, with OEMs (Original Equipment Manufacturers e.g. Tesla, Ford, Hyundai, etc.) rapidly forming joint ventures with key battery makers.

In 2022, the IEA estimates 1.57TWh of lithium-ion production capacity was online, with forecasts estimating the global capacity to reach 3.97TWh and 6.79TWh by 2025 and 2030 respectively.¹⁹ China is expected to maintain its dominance in lithium-ion capacity, accounting for 68% of global supply in 2030.

Figure: Global Lithium-ion Manufacturing Capacity 2022 relative to 2025 and 2030



Source: IEA World Energy Investment 2023, CEF Calculations

Note: Forecasts under Announced Pledges Scenario

¹⁷ IEA, [Global EV Outlook 2023 - EV Sales by Region 22-30](#), 13 April 2023

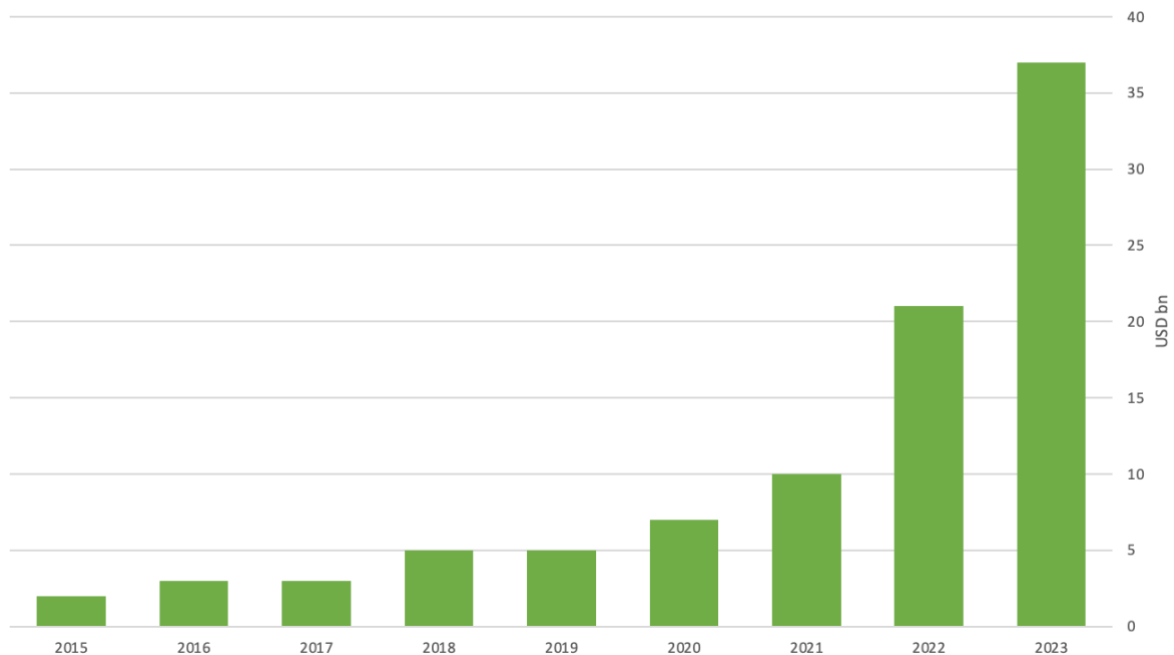
¹⁸ IEA, [Global EV Outlook 2023](#), 26 April 2023

¹⁹ IEA, [World Energy Investment 2023](#), 24 May 2023

The IEA forecasts the US to be the largest battery growth market from 2022-30, rising 836% in lithium-ion manufacturing capacity to over 1TWh by 2030. At this scale, the US would surpass Europe as the second-largest manufacturing jurisdiction, behind only China by 2030.

In addition to electrified transport, battery stationary storage is a significant growth engine for cell manufacturers. Annual investment into battery storage exceeded US\$20bn in 2022, with the US, China and Europe accounting for 90% of total expenditure. China’s expenditure tripled in 2022 to US\$8bn, with the US growing 50% to US\$6bn.²⁰ IEA forecasts investments to reach US\$37bn in 2023.

Figure: Global Battery Storage Annual Investment 2023 Forecast



Source: IEA World Energy Investment 2023, CEF Calculations

Note: 2023 is forecasted

In October 2022, BloombergNEF projected global energy storage installations to reach a cumulative 411GW (or 1,194GWh) by the end of 2030, more than a 15-fold increase from 2021 (27GW/56GWh).²¹

In March 2023, BloombergNEF calculated 16GW/35GWh of capacity was installed globally in 2022, up 68% from 2021. BNEF upgraded its forecast to 506GW/1,432GWh of global storage capacity by 2030 following ambitious energy storage targets worldwide.²² BNEF forecasts a 23% CAGR to 2030 in storage capacity, with annual installations reaching 88GW/278GWh by 2030.

Asia-Pacific is expected to maintain its lead on a power capacity basis (GW), with China leading the charge in deployment. Asia-Pacific nations have set ambitious targets and subsidies for deployment, with South Korea targeting 25GW/127GWh by 2036, and India providing funding for 4GWh of grid-scale batteries in its 2023-2024 budget.

²⁰ IEA, [World Energy Investment 2023](#), May 2023

²¹ BNEF, [Global Energy Storage Market to Grow 15-Fold by 2030](#), 12 October 2022

²² BNEF, [1H2023 Energy Storage Market Outlook](#), 21 March 2023

Section 1.1. South Korea's Battery Industry

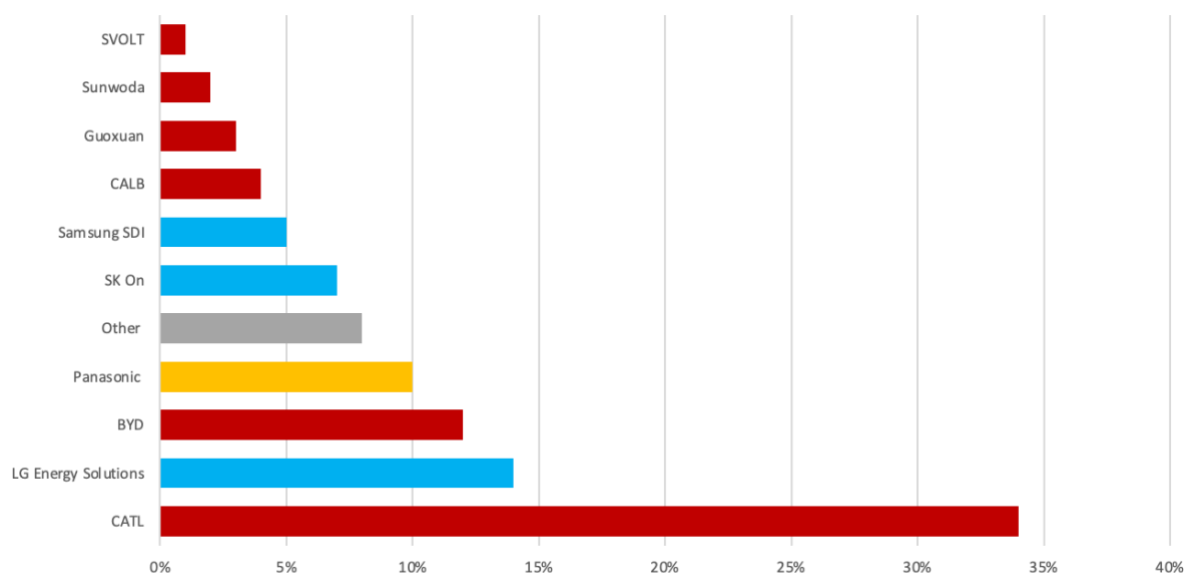
The automotive sector is now the largest contributor to Korea's trade balance, and recording strong growth. And within this, EV exports are booming, up 104% yoy in April 2023. Battery material exports are likewise surging to be a second key Korean export, and Korean battery manufacturers feature in the top 10 globally, second only to China. Korean battery firms are investing aggressively in new capacity, and reporting exceptional sales and profit growth.

South Korea's electrified transport industry is booming across the value chain. In April 2023, Korean automobile export revenue reached a record US\$6.2bn, up 40.3% yoy, bringing YTD 2023 auto-export revenue to another record, over US\$23.2bn.²³ Auto-exports are now the largest contributor to Korea's total trade balance. From 2023, the Korean Ministry of Trade, Industry and Energy (MOTIE) expects a 5-fold expansion of domestic automobile production to 2030, and 2023 auto-export revenue to exceed US\$80bn in 2023.²⁴

EV and Fuel Cell EV (FCEV) exports soared 103.7% yoy in April to US\$1.2bn, with PHEVs growing 67.5% over the same period. North America is one of Korea's fastest growing auto-export markets, up 52.9%, second only to Asia (up 61.2%) and outpacing European exports (up 29%). Korea's Institute for Industrial Economics and Trade (KIET) forecasts that given skyrocketing electrified transport and stationary storage demand, battery materials will be a top 5 export industry within the coming 5 years.²⁵

EV battery manufacturing is concentrated in China, with 6 of the top 10 manufacturers globally centred in China. The top two Chinese producers, CATL and BYD, supplied batteries to over 46% of EVs in 2022.

Figure: Global EV Battery Manufacturer Market Share 2022:



Source: SNE Research, CleanTechnica

²³ MOTIE, [Korea's Automobile Export Value Hits All-time High of \\$6.2bn in April](#), 18 May 2023

²⁴ MOTIE, [MOTIE Holds Automobile Parts Industry Strategy Roundtable](#), 26 May 2023

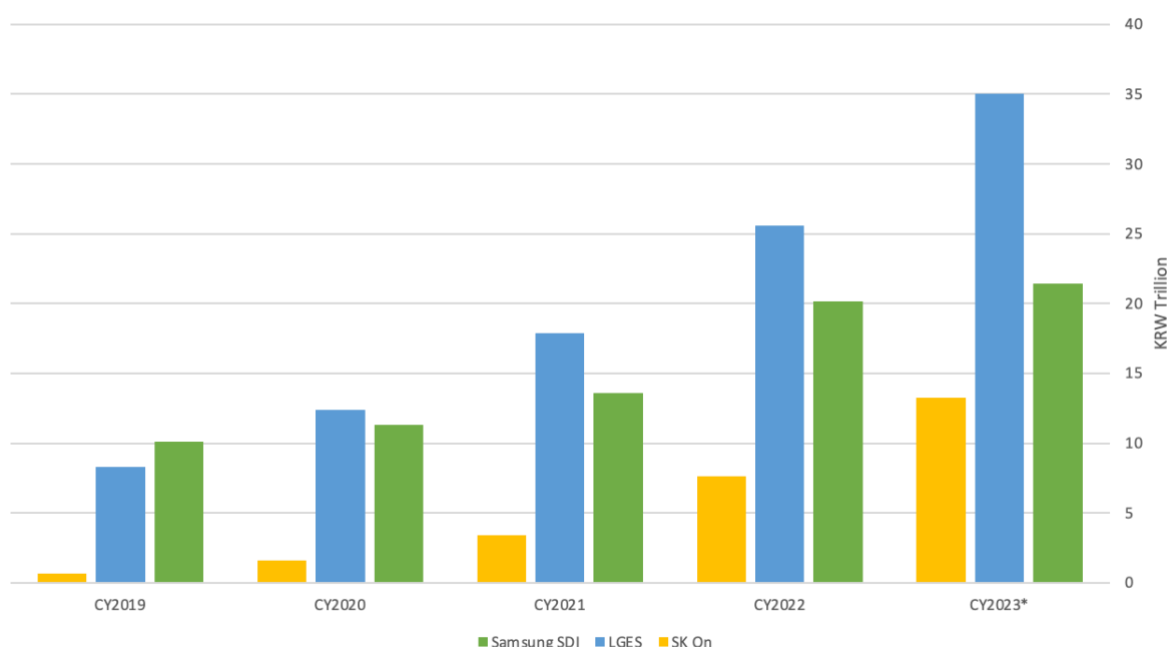
²⁵ MOTIE, [Minister Lee Reviews Future Tasks of Battery Industry](#), 30 May 2023

Significantly for the theme of this report, the second-largest global battery manufacturing jurisdiction is South Korea, with its majors (LG Energy Solutions, SK On and Samsung SDI) combining to 26% market share in 2022.²⁶

Automotive lithium cell demand grew over 65% in 2022 to 550GWh globally. Driven by accelerating adoption and deployment of EVs, the IEA estimates lithium-ion battery capacity to grow 332% from 2022 to 2030, a CAGR of 20%. Firms that address this opportunity strategically, directing capital flows at speed and scale, will be positioned to seize the significant earnings potential of the battery growth market.

This is South Korea’s strategy. From US\$27bn combined revenue in 2021, the Korean battery majors²⁷ are forecast to have a combined revenue of US\$121bn by 2025, growing over 348%.²⁸ In April 2023, the South Korean government announced KRW 7 trillion (US\$5.5bn) public support to underpin a joint investment pipeline of KRW 20 trillion (US\$15.1bn) in lithium battery technology and capacity advancements in partnership with South Korea’s dominant battery manufacturers through to 2030 in response to the US IRA.²⁹

Figure: Revenue Growth of SK Firms Battery Divisions 2019-2023



Source: Company Accounts, CEF Calculations
 Note: CY2023 data annualised from 1QCY2023 Earnings

LG Energy Solutions (LGES) is the second-largest global battery producer, behind CATL. In 1QCY2023, LGES posted KRW 8.75 trillion (US\$6.9bn) in revenue, up over 101% from 1QCY2022. This translated to an operating profit of KRW 633 billion (US\$500m), more than 50% of total profits received in the entirety of 2022. LGES achieved a KRW 1.15 trillion EBITDA

²⁶ CleanTechnica, [World’s Top 10 EV Battery Producers 2022](#), 11 October 2022

²⁷ LG Energy Solutions, SK On and Samsung SDI

²⁸ Korea Herald, [Korean Battery Makers set for Growth as Demand Outside China Soars](#), 20 September 2022

²⁹ Reuters, [South Korea Announces \\$15bn Investment in Advanced Battery Technologies](#), 20 April 2023

(US\$908m), up 70% yoy. Over the quarter, capex reached KRW 1.8 trillion (US\$1.4bn), a 45% increase from 1QCY2022.³⁰

Samsung SDI achieved a KRW 5.35 trillion (US\$4.2bn) revenue in 1QCY2023, up 32.2% yoy. In 2022, SDI posted record earnings of KRW 20.1 trillion (US\$15.9bn) revenue, growth of 48% from 2021 off the back of EV and stationary storage battery demand.

SK On, a subsidiary of SK Innovation, is the smallest battery producer of the Korean majors, but scaling rapidly. In 1QCY2023, SK On posted a KRW 3.3 trillion (US\$2.6bn) revenue, up 162% yoy.³¹ In 2022, SK On achieved record-breaking revenue of KRW 7.62 trillion (US\$6bn), up 151% from 2021.

The Korean battery majors are supporting their incredible earnings growth into new capacity and facility expansion, both off-shore and domestically. **Samsung SDI** invested KRW 618.8 billion (US\$489m) into capital expenditure (capex) over 1QCY2023, following a full year capex of KRW 2.5 trillion (US\$2bn) in 2022.

In 2022, **LGES** invested KRW 6.3 trillion (US\$5bn) into growth capex, up 57.5% from 2021 off the back record revenue, posting KRW 25.6 trillion (US\$20.2bn) for the year. In 2022, LGES had 200GWh of installed capacity across EV pouch cells (cells enclosed in an aluminium-coated plastic film, required for solid-state batteries), cylindrical cells and stationary storage capacity, translating to 14% global market share. LGES is targeting a capacity of 300GWh in 2023, investing into capacity expansions in alignment with key OEMs across North America, Europe and Asia. LGES forecasts to reach 555GWh capacity by 2030.³²

By 2023, **SK On** has 8 battery manufacturing facilities across Korea, Europe, US and China. China is currently SK's largest footprint, with ~ 45GWh of capacity. However, SK has directed significant capital into scaling its footprint in North America in response to the US IRA. SK's current investment pipeline will position the US as its largest sphere of operation by a significant margin, with over 150GWh by 2025.

³⁰ LGES, [Q1 2023 Earnings Conference Call](#), 26 April 2023

³¹ SK On, [2023 1Q Earnings Release](#), 4 May 2023

³² LGES, [LG Energy Solution Q4 2022 Earnings Conference Call](#), 27 January 2023

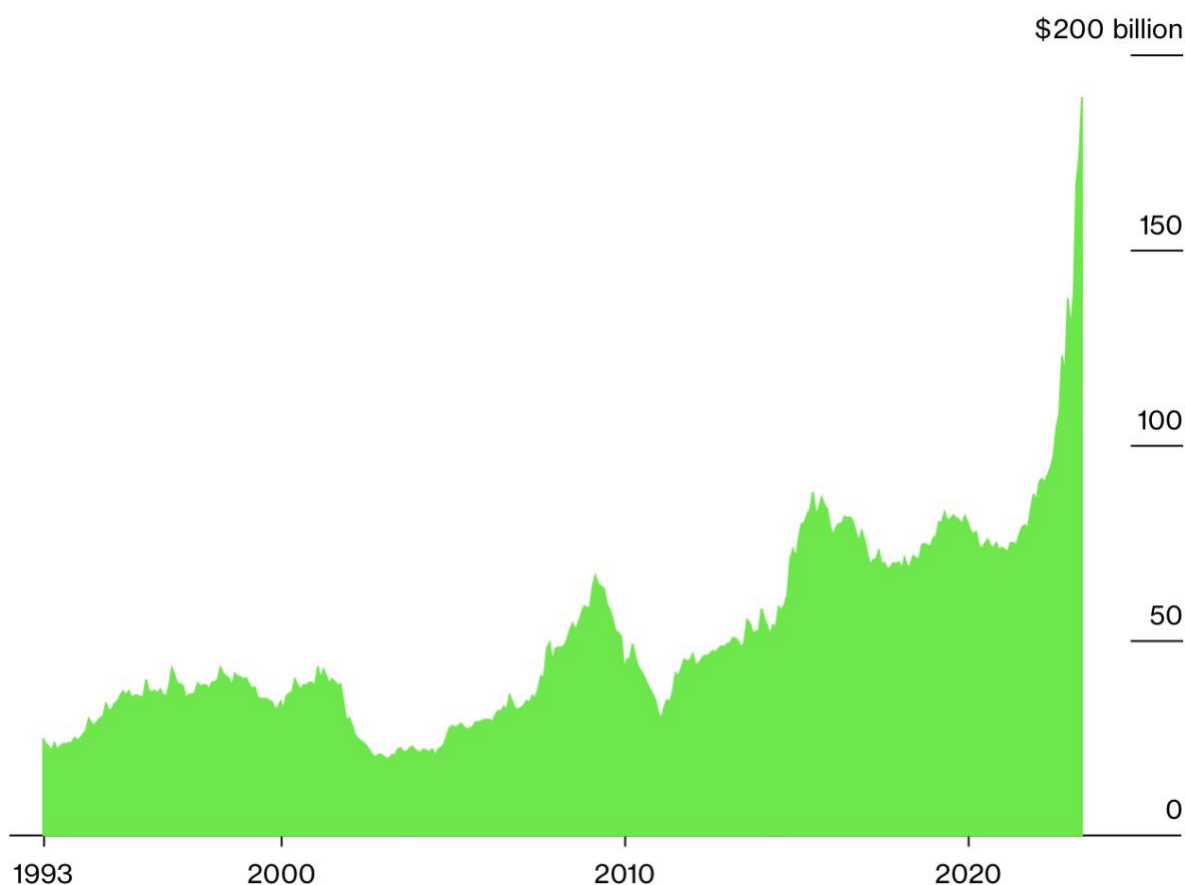
Section 2. Implications of the US IRA for Batteries and EVs

The IRA has driven an unprecedented manufacturing boom in the US, and battery and EV manufacturing sectors are central to this new investment. South Korea is the leading foreign investor in new battery facilities in the US, with private firms working collaboratively with financial support from the government's MOTIE, K-SURE and US EXIM, plus the DoE LPO leveraging the Korean-US FTA.

The Inflation Reduction Act (IRA) is a clear indication that the US is rapidly seeking to both diversify its over-dependence on China across the cleantech landscape and challenging China's global technology and manufacturing leadership. The IRA offers significant subsidies and capital incentives for reshoring US battery manufacturing.

Foreign direct investment (FDI) into the US has been turbocharged by the US\$369bn US government subsidy, grant and tax credit packages. From the IRA, CHIPS Act and a general mindset of reshoring domestic capacity, manufacturing investment is booming across new energy industries, including semiconductors, EVs, batteries and cleantech, highlighting the significant momentum in the figure below.

Figure: US Private Construction by Manufacturers



Source: US Census Bureau, [Bloomberg](#)

The Inflation Reduction Act has scaled the Department of Energy's (DoE) Loan Program Office (LPO) to a mammoth capacity. Over the past 14 years, the LPO disbursed near US\$33bn in government-backed loans to firms seeking to onshore cleantech manufacturing. Since the IRA, the LPO's available lending has sky-rocketed to over US\$400bn.³³ Jigar Shah, the Director of the LPO, aims to deploy sufficient capital at speed to bring key technologies down the cost curve, deploying US\$100bn of public capital to cross the bridge to bankability across each cleantech sector. In an interview with Bloomberg in June 2023, Jigar Shah aims to provide the facility to 20 technologies, hoping to grow the LPO to US\$2 trillion.³⁴

Since its passage in August 2022, an investment pipeline of US\$50.1bn into batteries and US\$2.8bn into EV charging infrastructure has been announced in the US, from both domestic firms and key trade partners Korea, Japan and Taiwan.³⁵ Announced investments into battery and EV production are now estimated at US\$75-108bn.³⁶

The IRA's push-pull mechanism, incentivising both demand and supply markets, has led to significant direct investment into EVs and battery supply chains from South Korea, as it recognises and responds to the North American battery opportunity. Capital is flowing, and flowing fast, both private and government.

April 2023 saw the South Korean government announce US\$5.3bn in financial support of its key battery manufacturers seeking to scale their infrastructure across the North American supply chain.³⁷ The support involves a 20% reduction in lending rates and insurance premiums in addition to various loan and tax credit programs through the Ministry of Trade, Industry and Energy (MOTIE).

Further, South Korea's established FTAs with the US (KORUS) and Canada (CKFTA) have leveraged public-private partnerships and joint-funding mechanisms between export credit agencies, and catalysed new investment across the Pacific. The growth of South Korea's battery industry is a product of consistent, strategic cooperation between its export credit agencies, development and export-import banks and private enterprise seeking to maximise domestic value from the global battery industry.

September 2022 saw the US Export-Import Bank (US EXIM) and the Korea Trade Insurance Corporation (K-SURE) sign a cooperative financing agreement, facilitating joint US and Korean export projects in critical minerals, climate technologies, semiconductors, rechargeable batteries and global supply chains.³⁸

This is helping to fuel the rapid expansion of secondary battery capacity in the US from South Korean firms, as Korea leverages its FTA to maximise chemical processing, precursor, and electrode manufacturing on-shore, whilst extracting the capital benefits of downstream pack assembly in the US.

³³ Bloomberg, [Transcript: A \\$9bn Deal to Supercharge US Cleantech](#), 22 June 2023

³⁴ Bloomberg, [Transcript: A \\$9bn Deal to Supercharge US Cleantech](#), 22 June 2023

³⁵ Bloomberg, [How the World is Spending \\$1.1 Trillion on Climate Technology](#), 24 April 2023

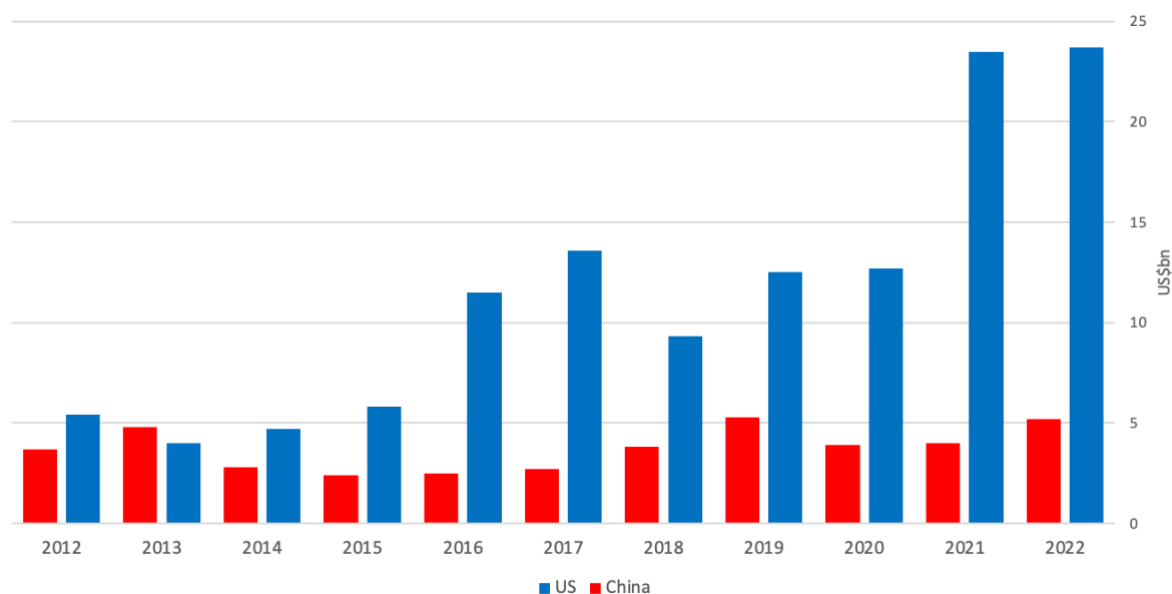
³⁶ IEA, [Global EV Outlook 2023](#), 26 April 2023

³⁷ Reuters, [South Korea to Offer \\$5.3bn in Financing to Support Battery Investment in North America](#), 7 April 2023

³⁸ EXIM, [EXIM Co-financing Agreement with K-SURE During UN General Assembly](#), 22 September 2022

Even prior to the IRA, South Korea had already pivoted its attention to the US from a macroeconomic perspective, with the US surpassing China as its key FDI destination for the past decade. In 2022, Korea’s FDI to the US reached US\$23.7bn, compared to US\$5.2bn into China.

Figure: South Korean Foreign Direct Investment US and China



Source: Korea Eximbank via Bloomberg ³⁹

IRA Clean Vehicle and Manufacturing Production Credits

The IRA introduced the **Clean Vehicle Tax Credit** (Section 30D of the Internal Revenue Code). Section 30D classifies midstream battery products as within the scope of critical minerals, categorised as constituent materials. The value-add processing of critical minerals into hydroxides, sulphates, precursor materials, as well as products further downstream in battery production including cathode active materials (CAM), metals for solid electrodes, electrolytes, foils and additives, is eligible to receive half the Clean Vehicle Tax Credit if manufactured in countries with FTAs. South Korea and Australia both currently have comprehensive FTAs with the US.

Section 30D provides a US\$7,500 maximum credit per EV to consumers, conditional on meeting critical mineral and battery component requirements.⁴⁰ Consumers are eligible, from 1 January 2023, to receive a tax credit of US\$3,750 if 40% or more of the critical mineral components of an EV are extracted and processed either onshore or in a country with which the US has an FTA. The requirement will increase 10% annually until 80% of the extraction and processing demands meet the criteria by 2026. Consumers can receive a further US\$3,750 credit if 50% or more of the battery component manufacturing and assembly occurs in North America. This requirement will tighten by 10% annually until 100% of battery production and assembly is onshore by 2028.

The IRA also introduced the **Advanced Manufacturing Production Tax Credit (AMPTC)** (Section 45X of the Internal Revenue Code) which applies to energy and advanced technology

³⁹ Bloomberg, [South Korea to Avoid Cashing in on China’s US Chipmaker Ban](#), 28 May 2023

⁴⁰ BloombergTax, [Sec. 30D. Clean Vehicle Credit](#)

manufacturing, including solar energy components, wind energy components, power inverters and battery components.

The AMPTC grants battery manufacturers with domestic operations a tax credit of \$35/kWh for battery cells and a further \$10/kWh for battery modules assembled and sold in the US from 2023. The production tax credits will phase out from 31 December 2029, reducing eligible components to 75% of production in 2030, 50% by 2031, 25% by 2032 and 0% by 2033.⁴¹

How South Korea is leveraging the IRA – key projects

South Korea's battery majors have capitalised on the US tax credit and subsidy program, establishing joint ventures with key EV manufacturers including Ford, GM, Stellantis, Honda and Hyundai. Of the current 22 EV models eligible to receive the tax credits, 17 are supplied from LG Energy Solutions, SK On and Samsung SDI.⁴²

In March 2023, **LG Energy Solutions** (LGES) announced the US\$5.5bn Arizona battery manufacturing complex, the largest stand-alone battery manufacturing facility in North America.⁴³ The 43GWh complex will consist of a US\$3.2bn, 27GWh cylindrical cell facility, producing lithium-ion cells for the US EV industry. The second component is a US\$2.3bn, 16GWh stationary storage facility, producing LFP (lithium iron-phosphate) battery cells. The facilities are set to come online in 2025 and 2026 respectively. An important note is that the scale of the complex is 4x larger than previously announced by LG, following the implementation of the IRA.

In the same month, LGES began construction of a second US\$4.4bn EV battery facility in Ohio. The 40GWh facility is a joint venture alongside Honda to service the latter's North American EV strategy.⁴⁴ The plant is expected to start production in 2025, aligning with Honda's roadmap to commence EV production by 2026. The plant is expected to create 2,200 jobs.

In May 2023, LGES announced a partnership with Hyundai Motor Co. to jointly construct a third US\$4.3bn battery cell manufacturing facility in Savannah, Georgia.⁴⁵ The 30GWh facility would be capable of supporting 300,000 EVs annually due to the technological patents held by LG Chem that provide a claimed 20-30% improvement in performance from their cathode material compared to key competitors.

In March 2022, LGES announced a partnership with Stellantis to invest over C\$5bn for Canada's first large-scale battery production plant in Windsor, Ontario.⁴⁶ The 45GWh facility would create 2,500 new jobs.

LGES and GM's battery partnership, **Ultium Cells**, is constructing three new plants across the US, a 50GWh Michigan plant, 35GWh Ohio plant and 35GWh Tennessee plant, expected to be completed between 2023-25. Following the introduction of the IRA, and the subsequent

⁴¹ BloombergTax, [Sec. 45X. Advanced Manufacturing Production Credit](#)

⁴² Financial Times, [South Korean Battery Groups' Domination of EV Market in US Faces China Challenge](#), 26 April 2023

⁴³ LGES, [LGES to Invest KRW 7.2Trillion to Build Battery Manufacturing Complex in Arizona](#), 24 March 2023

⁴⁴ LGES, [LGES and Honda Break Ground for New JV EV Battery Plant in Ohio](#), 2 March 2023

⁴⁵ Hyundai, [HMG and LGES to Establish Battery Cell Manufacturing JV in the US](#), 26 May 2023

⁴⁶ LGES, [Stellantis and LGES to Invest over C\\$5bn in JV for First Large-Scale Battery Plant](#), 23 March 2022

expansion of the US Department of Energy's Loan Program Office (LPO), in December 2022, Ultium Cells was awarded a US\$2.5bn loan facility to finance a portion of the three new facilities onshore.⁴⁷

The loan was facilitated through the Advanced Technology Vehicles Manufacturing Program (ATVM) under the IRA, operating alongside the US\$7.5bn EV infrastructure and US\$7bn critical minerals supply chain program under the Bipartisan Infrastructure Law (BIL).

LGES' partnership with GM is of critical importance to the US economy, unlocking significant domestic manufacturing capacity and over 11,000 new jobs across the facilities. The Ultium Cells debt facility is the first closed loan exclusively for a battery cell manufacturing project under the ATVM program.

LGES is extracting the value and growth opportunities of the North American market spurred on by the IRA. In the firm's latest earnings report, LGES estimates it will receive KRW 100.3 billion (US\$79m) in tax credits from the IRA's AMPTC in 1QCY2023 alone.⁴⁸ LGES expects to receive ~KRW 1 trillion (US\$790m) in IRA subsidies in 2023, and as the firm closes in on its goal of 248GWh of domestic capacity, estimates it will receive as much as KRW 46.5 trillion (US\$36.7bn) in financial support over the coming decade.

In April 2023, **SK On**, in partnership with Korea's Hyundai Motor Co., is jointly developing a US\$5bn battery manufacturing facility in Georgia. The 35GWh plant is expected to be completed in the second half of 2025, employing 3,750 workers and capable of supporting 300,000 EVs annually.⁴⁹

Between federal and state incentives, the JV could receive up to US\$700m in tax breaks and grants for the development and operation of the plant; specifically, US\$247m in local property tax breaks over 20 years, US\$98m in project tax credits, a US\$46m grant for a water treatment plant, US\$11m in workforce training grants, and a further US\$40m in grants.⁵⁰

Output from the new SK On Georgian plant would feed Hyundai and Kia's North American facilities. This includes Hyundai's EV and battery facility, Metaplant America, in Georgia. The US\$5.5bn facility is expected to produce EVs from 2025, creating over 8,100 jobs.⁵¹

BlueOvalSK is SK On's major US joint venture, partnering with Ford Motor Co. It is investing US\$11.4bn to construct two battery plants in Kentucky, and an EV/battery plant in Tennessee, creating 11,000 jobs across the three facilities. In September 2022, Ford broke ground on the US\$5.6bn EV and cell manufacturing facility, BlueOval City,⁵² and in December 2022, on the US\$5.8bn Kentucky BlueOvalSK Battery Park, comprising the two 43GWh gigafactories.⁵³

⁴⁷ US DoE, [\\$2.5bn Loan to Ultium Cells for Three Domestic Battery Cell Manufacturing Facilities](#), 12 December 2022

⁴⁸ Korea Bizwire, [LG Energy Solutions Profit Grew More than Twofold in Q1 on IRA Effects](#), 8 April 2023

⁴⁹ Hyundai, [HMG and SK On to Establish EV Battery Cell Production JV in US](#), 25 April 2023

⁵⁰ KED Global, [Hyundai and SK Battery JV May Receive up to \\$700m in US Grants](#), 7 June 2023

⁵¹ Hyundai, [HMG Breaks Ground on Metaplant America Dedicated EV plant](#), 25 October 2022

⁵² InsideEVs, [Ford Breaks Ground at BlueOval City](#), 23 September 2022

⁵³ Ford, [Ford and SK On Make Significant Construction Progress at BlueOvalSK Battery Park](#), 5 December 2022

In June 2023, BlueOvalSK was awarded a conditional loan for US\$9.2bn for the construction of the three battery plants across Tennessee and Kentucky, administered through the US DoE Loan Program Office.⁵⁴ The facility is the single largest loan in LPO's history.

BlueOvalSK is a critical component of SK On's growth strategy, adding 129GWh capacity to its global portfolio by 2025, making the US its largest manufacturing footprint. BlueOvalSK is also vital to Ford's growth strategy aimed at producing 2 million EVs annually by 2026.

In April 2023, **Samsung SDI** announced a joint venture with GM to invest over US\$3bn into a 30GWh domestic cell manufacturing plant in the US.⁵⁵ There is no announcement thus far on location for the project, but if realised, it would bring GM's total US cell capacity to ~160GWh across its joint ventures with LGES and Samsung SDI.

Figure: South Korean Battery Manufacturers Announced Capacity Expansion in the US

Manufacturer	Partner	State	Capacity (GWh)	Time
LGES	GM	MI	50	2025
LGES	-	MI	25	2025
LGES	Hyundai	GA	30	2025
Samsung SDI	GM	TBD	30	2026
Samsung SDI	Stellantis	IN	23	2025
Samsung SDI	Stellantis	IN	40	TBD
LGES	GM	OH	35	2025
LGES	Honda	OH	40	2025
SK On	Ford	KY	43	2025
SK On	Ford	KY	43	2026
LGES	GM	TN	35	2023
SK On	Ford	TN	43	2025
SK On	-	GA	10	Operating
SK On	-	GA	12	2023
SK On	Hyundai	GA	35	2025
LGES	-	AZ	43	2025

Source: Climate Energy Finance, using corporate announcements

A note on China and EV supply chain in the US

South Korea is not the only major nation racing to secure the dominant market share of the North American battery value chain. Despite the IRA's significant tax breaks and customer incentives for EVs assembled domestically and containing battery materials sourced from free

⁵⁴ Bloomberg, [Ford Gets \\$9.2bn to Help US Catch Up with China's EV Dominance](#), 22 June 2023

⁵⁵ Samsung SDI, [SDI and GM Plan to Establish JV for Battery Manufacturing](#), 26 April 2023

trade agreement partners with the US, this has not undermined China's dominant global position, a product of the scale of its EV operations.

The intellectual property (IP) and expertise of China's majors built over the last decade are invaluable to OEMs globally that are seeking to rapidly scale output to escape what Tesla's Elon Musk has labelled 'Manufacturing Hell', where manufacturers operate on negative margins before they can benefit from economies of scale.

Ford, for example, currently runs on low double-digit margins for its internal combustion engine (ICE) division, while its EV division operates at negative 40% margins, with losses expected to reach US\$3bn in 2023 as it looks to scale its way to positive earnings.⁵⁶

In February 2023, Ford announced a US\$3.5bn investment for a 35GWh EV battery production plant in Michigan partnering with world-leading Chinese manufacturer, CATL.⁵⁷ The partnership will license LFP cell IP and technology from CATL, integrating LFP chemistries into Ford's NCM and NCA cathode focussed line-up. The investment is part of Ford's mission to invest US\$50bn into EV value chains globally by 2026, with the Michigan plant adding to Ford's previous US\$17.6bn investments with key South Korean partners SK On (BlueOvalSK) and LGES.

In March 2023, Tesla announced it was in advanced discussions with CATL to implement a deal similar to Ford's, proposing a wholly owned new battery facility in Texas, licensing LFP technology from the Chinese conglomerate.⁵⁸

Notwithstanding the above, South Korea is in the best position to extract the value of North America's battery supply chain. In the subsequent section we take a deep-dive into the growth of South Korea's domestic battery materials industry and diversification from China's dominance in midstream activity. Further, we outline how the growth of Korea's midstream capacity opens a significant opportunity for Australia to diversify its supply chains and export markets in critical minerals, and scale value-added processing onshore.

⁵⁶ FT, [Ford Strikes Lithium Deals in Bid to Secure EV Battery Supplies](#), 23 May 2023

⁵⁷ Ford, [Ford Taps Michigan for new LFP Battery Plant](#), 13 February 2023

⁵⁸ Bloomberg, [Tesla Pursues Building a new US Plant with China's Dominant Battery Maker](#), 31 March 2023

Section 3. Korea's Battery Midstream Integration

South Korea is building a world leading integrated domestic battery precursor, cathode, cell and battery value chain to provide fast-growing and emerging electrified transport markets global diversification from the current total Chinese dominance. The IRA necessitates this for access to the rapidly growing US EV market.

A significant portion of growth capex within the South Korean battery value chain is being directed to scaling domestic midstream capability. **Midstream production** refers to the value-added chemical refining processes and the subsequent use in producing precursor and activated electrode material used in cell manufacturing.

South Korea's battery industry has historically specialised in high-nickel cathodes, meaning mineral processing of lithium, nickel, cobalt and manganese is of particular importance. Ernst & Young estimates 75% of a battery's value is from its cell, with module and pack assembly contributing to 11% and 14% respectively. Within the cell, cathodes make up 51% of embedded value, making cathode production the biggest value market across the battery supply chain.⁵⁹

Korea's downstream cell manufacturers are rapidly scaling their global footprint. To safeguard their investment pipeline against supply chain shocks, geopolitical interference and price instability, Korea's majors are offering significant cathode production contracts to domestic chemical companies seeking to integrate further into battery materials, particularly LG Chem's Advanced Materials, POSCO's Future M and EcoPro's Battery Materials.

Currently, Korean battery manufacturers import more than 90% of their precursor demand from China.⁶⁰ In order to extract the benefits of the IRA, onshoring cathode and precursor capacity is imperative to the Korean economy, given the critical importance of electrified transport and battery exports to the economy's trade balance.

LG Chem

In 1QCY2023, LG Chem posted a 25% yoy revenue growth to KRW 14.5 trillion (US\$11.5bn), with LG Energy Solutions and Advanced Materials divisions contributing KRW 8.74 trillion (US\$6.9bn) and KRW 2.56 trillion (US\$2bn) respectively.⁶¹ Despite representing just 17% of LG Chem's revenue, Advanced Materials is a critical aspect of LG Chem's future development and growth.

LG Chem was the world's first producer of large-scale NCM cathode material, owning over 40 patents related to high-nickel cathode material production.⁶² In March 2023, LG announced the possibility of licensing its patents to China-based third parties in exchange for royalties to boost the earnings of its Advanced Materials division, and geographically diversify its earnings across Korea, China, US and Europe.

⁵⁹ EY, [How Europe can Unlock the Midstream Battery Materials Bottleneck](#), 19 May 2023

⁶⁰ KED Global, [LG Chem and China's Huayou Cobalt to Build \\$923m Precursor Plant](#), 14 April 2023

⁶¹ LG Chem, [LG Chem Posts 1Q Management Performance](#), 27 April 2023

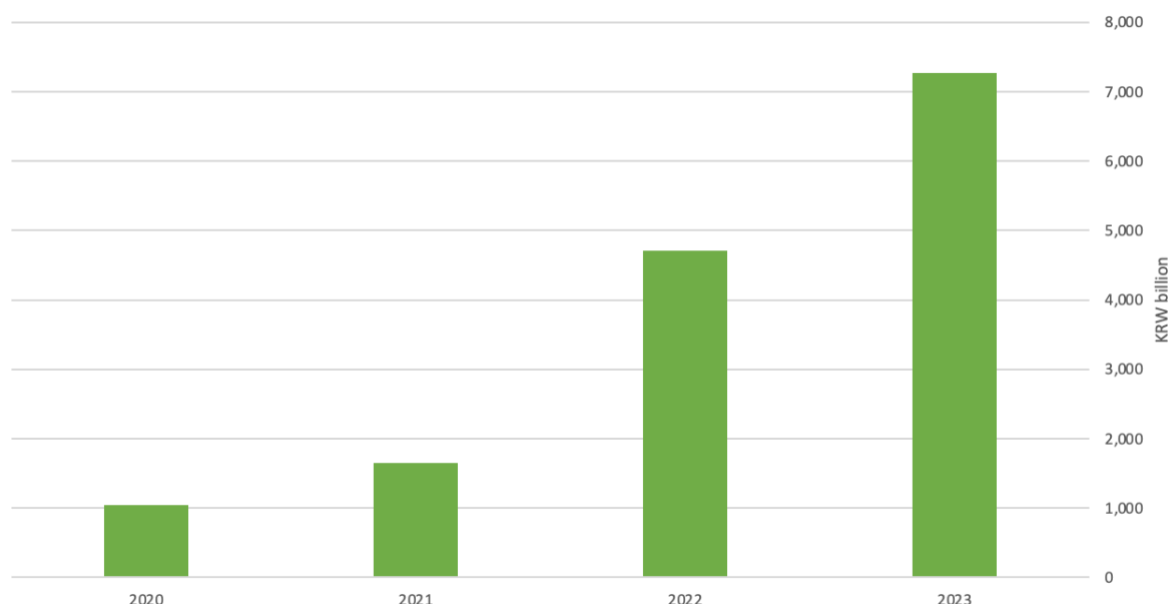
⁶² LG Chem, [LG Chem Enforces its Patent Rights in High-Nickel Cathode Battery Materials](#), 17 March 2023

In 2023, LG Chem announced its strategic focus on expanding its battery materials division as one of three primary growth engines through 2030. LG Chem forecasts an annual revenue growth rate of 26% in battery materials to US\$25.5bn by 2030, channelling growth capex into market share, technological development and supply chain procurement.⁶³

LG Chem is investing rapidly to scale its earnings from cathode production from KRW 5 trillion (US\$4.0bn) in 2022 to over KRW 20 trillion (US\$15.8bn) by 2027.⁶⁴ Currently, LG Chem operates 2 domestic cathode plants, Cheongju and Iksan, and an offshore plant in Wuxi, China, aggregating to 80ktpa capacity. The Wuxi cathode facility was co-developed in partnership with China’s Huayou Cobalt, the largest cobalt refiner in the world. In 2019, the joint venture also established a precursor material facility in Quzhou, China.

In precursor and cathode production, LG Chem is expanding its line-up of high-nickel cathodes, LFP, and manganese-rich battery materials from 88ktpa in 2022 to ~120ktpa in 2023 before quadrupling production to 470ktpa by 2028, expanding its customer network beyond LG Chem’s subsidiary LG Energy Solutions and its various joint ventures. LG also announced a channel of R&D capex into silicon anode material and solid-state electrolytes.

Figure: Revenue Growth of LG Chem AM Battery Materials Division



Source: Company Accounts, CEF calculations

Note: CY2023 data annualised from 1QCY2023 Earnings

In July 2022, LG Chem announced a supply agreement for 950kt of cathode material over 8-years through to 2030 to LG and GM venture, Ultium Cells.⁶⁵

In November 2022, LG Chem signed an MoU with the state of Tennessee, US, for the development of a US\$3bn cathode manufacturing facility in Clarksville, capable of producing 120ktpa by 2027, powering over 1.2 million EVs annually.⁶⁶ The new cathode facility is

⁶³ LG Chem, [Sixfold Sales Growth in Battery Materials to KRW 30 trillion by 2030](#), 16 May 2023

⁶⁴ LG Chem, [Establish Largest Cathode Plant in US for EV Batteries](#), 22 November 2022

⁶⁵ Korea Herald, [LG Chem to Supply CAM to GM for 8 Years](#), 27 July 2022

⁶⁶ LG Chem, [Establish Largest Cathode Plant in US for EV Batteries](#), 22 November 2022

strategically located next to LG Chem’s downstream assets in development across Tennessee, Kentucky, Georgia and Ohio with key OEMs in GM, Hyundai and Honda.

In January 2022, LG Chem announced the start of construction of a cathode production facility in Gumi, South Korea. In May 2022, LG Chem announced it had entered into a 51:49 JV with Huayou Cobalt’s subsidiary, Tianjin B&M, for the Gumi cathode project, with Huayou investing KRW 500 billion (US\$395m) into the project. Combined, the KRW 1 trillion (US\$790m) facility will house 60ktpa capacity of high-nickel cathode production lines.⁶⁷ The plant will produce sufficient NCMA cathode material to power 500,000 high-range EVs (~500km).

In April 2023, LG Chem enhanced its partnership with Huayou Cobalt for the co-development of a KRW 1.2 trillion (US\$948m) battery precursor facility in Saemangeum National Industrial Complex, North Jeolla Province, Korea.⁶⁸ A 50ktpa capacity Phase I plant is expected to commence production in 2026, ramping to 100ktpa by 2028, capable of fuelling over 1 million EVs annually (at 75KWh). The facility will house metal refineries to produce sulphates, the key constituents for NCM (nickel, cobalt and manganese) cathode production. Product will be shipped to LG Chem’s global network of cathode plants, particularly to supply LGES’ cell manufacturing plants in the US.

In June 2022, LG Chem established a joint venture with Korea Zinc’s KEMCO, a nickel sulphate producing subsidiary. The 51:49 partnership (favouring KEMCO) was established to construct a KRW 200 billion (US\$158m) precursor and recycled metals plant in Ulsan, Korea.⁶⁹ The 20ktpa capacity is expected to be completed in 2024, and will feed precursor material into LG Chem’s Cheongju cathode plant.

Figure: Summary of LG Chem Midstream Investment Pipeline

Facility	Partner	Product	Location	Cost	Time
Tennessee	-	Cathode	US	US\$3bn	2027
Gumi	Huayou	Cathode	Korea	US\$790m	2024
Saemangeum	Huayou	Precursor	Korea	US\$948m	2026
Ulsan	KEMCO	Precursor	Korea	US\$158m	2024

Source: Climate Energy Finance, using corporate announcements

POSCO Future M

POSCO’s battery materials division, POSCO Future M, has established itself as a global tier-1 battery chemicals company, directing multi-billion-dollar capital flows into the growth of its high-nickel cathode material and artificial graphite and silicon anode material industry.⁷⁰ Through POSCO Holdings various subsidiaries, Future M has secured an integrated value chain from mineral extraction to activated cathode materials, strengthening Korea’s supply chain resilience and over-dependence on foreign jurisdictions.

⁶⁷ LG Chem, [Establish JV to Produce Cathode Material with Huayou Cobalt](#), 31 May 2022

⁶⁸ LG Chem, [Invest KRW 1.2 trillion for Battery Precursors Plant in Korea](#), 17 April 2023

⁶⁹ LG Chem, [LG Chem and Korea Zinc Subsidiary KEMCO Establish JV for Recycling-Precursors](#), 2 June 2022

⁷⁰ POSCO FM, [KRW 30 trillion Order for High-Nickel Cathode materials from LGES](#), 26 April 2023

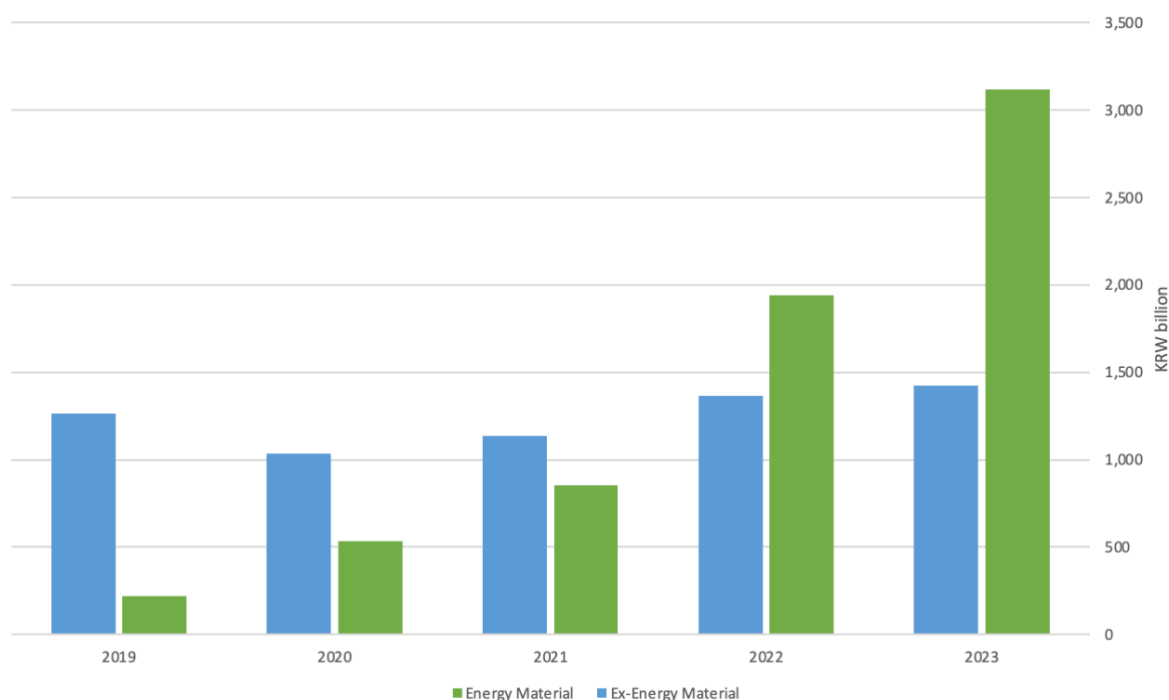
Future M has a total of 8 cathode and anode facilities domestically and offshore, making POSCO the only Korean firm to have an integrated supply chain for both cathode and anode manufacturing, and is currently the only anode producer in the nation.

POSCO has experienced rapid earnings growth off the back of demand from LGES and Samsung SDI. In 1QCY2023, Future M achieved a revenue of KRW 1.135 trillion (US\$897m), up 71% yoy, generating an EBITDA of KRW 49.1 billion (\$38.7m), up 6% yoy.⁷¹ In 2022, revenue grew by 66% to KRW 3.3 trillion (US\$2.61bn), generating 26% growth in EBITDA to KRW 257.2 billion (US\$203m).⁷²

Future M contains its Energy Materials (EM) division, under which all cathode and anode production occurs, and its steel business, including Advanced Chemical Materials (value-added carbon materials from coking coal by-products), Basic Industrial Materials (refractories and burnt lime) and MC Materials, a 60:40 joint venture between Future M and Mitsubishi Corporation of Japan.

POSCO is the largest steelmaker in South Korea, with MC Materials producing needle coke electrodes, an essential component in operating electric arc furnaces. Steel-related industries have been the fundamental component of Future M's operations since its inception, accounting for over 85% of Future M's revenue as recently as 2019. By 2022, EM surpassed Future M's steel subsidiaries, accounting for 59% of total revenue. Now, in the first quarter of 2023, EM accounts for 69% of total revenue for Future M.

Figure: Revenue Growth of POSCO Future M 2019-2023



Source: Company Accounts, CEF Calculations
 Note: CY2023 data annualised from 1QCY2023 Earnings

⁷¹ POSCO FM, [1Q 2023 Earnings Release](#), 27 April 2023

⁷² POSCO FM, [2022 Earnings Release](#), 27 January 2023

The future growth of LGES, Samsung SDI and SK On requires a significant expansion in supply chain procurement and midstream capacity. To feed the 100s of GWh growth of Korea’s cell manufacturing, the battery majors have awarded significant off-take partnerships to POSCO Future M.

In April 2023, LGES and Future M signed a 7-year cathode materials off-take agreement valued at KRW 30.3 trillion (US\$23.9bn) through 2029.⁷³ Future M will supply LGES with high-nickel NCM(A) (nickel, cobalt, manganese and aluminium), adding to the previous partnership with LGES since Future M entered the battery materials industry in 2011.

In July 2022, Ultium Cells (a North American joint venture between General Motors and LGES) signed an upgraded large-scale cathode supply agreement valued at KRW 13.77 trillion (US\$10.9bn).⁷⁴

In December 2022, Future M announced a partnership with Ultium for the large-scale supply of artificial (synthetic) graphite anode material, valued at KRW 939.3 billion (US\$743m).⁷⁵ Between Ultium Cells and LGES direct contracts, POSCO has a KRW 52 trillion (US\$41.1bn) partnership to date.

In January 2023, Future M signed a 10-year agreement with Samsung SDI through 2032 for the supply of high-nickel NCA cathode material, valued at KRW 40 trillion (US\$31.6bn).⁷⁶ The Samsung SDI partnership is the largest contract in Future M’s history, marking the scale and growth opportunity present for South Korea’s battery value chain and trade partners.

Figure: POSCO Future M Current Supply Contracts with South Korean Battery Firms

Material	Customer	KRW (tn)	Contract (US\$)	Length
NCM(A) Cathode	LGES	30.26	23.91bn	2023-29
NCA Cathode	Samsung SDI	40	31.60bn	2023-32
NCMA Cathode	Ultium Cells	13.77	10.88bn	2023-25
NCMA Cathode	Ultium Cells	8.39	6.63bn	2023-33
Artificial Anode	Ultium Cells	0.94	743m	2023-28

Source: POSCO Future M ⁷⁷

Future M: Gwangyang Hub

The port city of Gwangyang, in South Jeolla Province, is the beating heart of POSCO’s battery material operations. In 2018, Future M completed its first domestic cathode facility in

⁷³ POSCO FM, [KRW 30 trillion Order for High-Nickel Cathode materials from LGES](#), 26 April 2023

⁷⁴ POSCO FM, [POSCO Chemical and General Motors Announce Agreement for Large-Scale Supply of CAM](#), 28 July 2022

⁷⁵ POSCO FM, [Agreement with Ultium Cells for Large-Scale Supply of Artificial Graphite Anode Material](#), 5 December 2022

⁷⁶ POSCO FM, [40 trillion KRW Cathode Supply Contract for Samsung SDI’s Batteries](#), 30 January 2023

⁷⁷ POSCO FM, [KRW 30 trillion Order for High-Nickel Cathode materials from LGES](#), 26 April 2023

Gwangyang, with a capacity of 5ktpa. With changing market dynamics and a burgeoning electrified transport industry, Future M added a 25ktpa Phase 2 expansion to meet growing demand. Fast forward 4 years, to November 2022, Future M completed Phase 4 of Gwangyang (precursor (pCAM) plant) and cathode material facility, boosting total capacity of the Gwangyang hub to 90ktpa.⁷⁸ Specialising in high-nickel NCM(A) cathode production, it is now the world's largest cathode material production facility. At 165,203m², the facility is the size of 23 football fields.

To date, POSCO has an installed cathode capacity of 105ktpa across Korea and China, with 90ktpa from Gwangyang.

In March 2022, Future M signed an agreement with the city of Gwangyang to invest KRW 600 billion (US\$474m) into a precursor-CAM facility to integrate into its CAM hub in the Gwangyang Value Chain Cluster. The facility is expected to produce 100ktpa of precursor material, sufficient to supply 1.2 million EVs.⁷⁹ Future M has a planned investment pipeline to produce 185ktpa by 2025, forming a vertically integrated ecosystem across the entire battery value chain.

In 2019, POSCO partnered with China's Huayou Cobalt to form POSCO HY Clean Metal, an entity seeking to extract the value of black mass (cathode material) from retired battery packs. In September 2021, POSCO HY Clean Metal announced the start of construction for a KRW 120 billion (US\$95m) battery recycling facility in Yulchon Industrial Park, Gwangyang.⁸⁰ The plant will extract 12ktpa of black mass (lithium, nickel and cobalt) that will feed into POSCO's expanding Gwangyang cathode industry.

The Gwangyang Value Chain Cluster is now home to the 90ktpa CAM facility, a 45ktpa pCAM facility, the POSCO HY Clean Metal 12ktpa recycling plant, and POSCO's 43ktpa lithium hydroxide refinery, built in partnership with Australia's Pilbara Minerals. The POSCO Pilbara Lithium Solutions facility is discussed in Section 4.2. Gwangyang is also home to POSCO's KRW 230 billion (US\$182m) value-added nickel sulphate facility, set to finish construction in 2023. The plant will have an annual production of 20ktpa, enough to supply 500,000 EVs annually.⁸¹

In April 2023, POSCO announced the investment consideration for up to KRW 4.4 trillion (US\$3.5bn) into Gwangyang's Industrial Complex by 2033 to boost new growth in rechargeable battery components and hydrogen.⁸² In May 2023, The Korea Economic Daily reported POSCO had purchased further land in the Yulchon Industrial Complex, Gwangyang for KRW 120 billion (US\$95m), with reports POSCO is near an investment decision to build a further 25ktpa lithium hydroxide facility, and 60ktpa cathode production facility, for production to commence by 2025. The construction of the new assets is estimated at KRW 1.2 trillion (US\$948m), boosting Gwangyang CAM capacity to 150ktpa, sufficient to power 1.87 million EVs annually.⁸³

⁷⁸ POSCO FM, [POSCO Chemical Completes World's Largest Cathode Plant](#), 10 November 2022

⁷⁹ POSCO FM, [POSCO Chemical Invests in a 100,000-ton Precursor Factory in Gwangyang](#), 7 March 2022

⁸⁰ Huayou, [Construction of Korean Joint Venture – POSCO HY Clean Metal](#), 1 October 2021

⁸¹ KED Global, [POSCO to Build \\$200m Nickel Refining Plant to Ramp Up Battery Materials](#), 28 July 2021

⁸² KED Global, [POSCO Mulls \\$3.3bn Investment in Industrial Cluster by 2033](#), 19 April 2023

⁸³ KED Global, [POSCO to Spend \\$900m to Expand Lithium and Cathode Output in Korea](#), 2 May 2023

Future M: Pohang Hub

Future M has now secured the fundamental customer partnerships that has catalysed the next phase of POSCO's capex into battery materials. POSCO is directing billions (AUD) into establishing integrating battery material hubs across South Korea, creating synergies and cost-efficiencies across mineral refining (producing hydroxides and sulphates) and chemical processing (precursor-CAM and CAM).

Pohang, the largest city in North Gyeongsang Province, is the newest production hub for Future M. Pohang's Yeongilman General Industrial Complex is home to POSCO's Phase 1 cathode facility in development, with a capacity of 30ktpa of NCMA cathodes. Phase 1 is expected to be completed in 2HCY2023.

On 24 April 2023, Future M approved the KRW 614.8 billion (US\$486m) investment decision to expand NCMA cathode production capacity at Pohang. The new production (Pohang Phase 2-2) line will add 46ktpa, bringing total NCMA capacity in Pohang to 76kt annually.⁸⁴ Pohang 2-2 is expected to complete construction by 2025.

On 28 April 2023, Future M reached FID on a further KRW 392 billion (US\$310m) expansion, Pohang Phase 2. Phase 2 is a solely-dedicated NCA cathode plant, with capacity of 30ktpa, set to begin mass production by 2025.⁸⁵ The NCA plant will add diversified capacity to POSCO's global network, supplying its new KRW 40 trillion (US\$31.6bn) agreement with Samsung SDI. This will be sufficient to produce 300,000 NCA cathode powered EVs annually. Combined, Pohang will have a cathode capacity of 106ktpa across the three facilities.

In May 2023, Future M signed an MoU with Huayou Cobalt, Pohang City and Gyeongsangbuk-do, to jointly invest KRW 1.7 trillion (US\$1.34bn) into establishing a battery materials value chain cluster in Pohang.⁸⁶ In Pohang's Blue Valley Industrial Complex, the joint venture will establish a precursor cathode materials facility and a value-add high-purity nickel refinery, estimated at KRW 1.2 trillion (US\$948m) by 2027. The Blue Valley value chain cluster would provide a vertically integrated supply of critical midstream products to Future M's Pohang cathode cluster.

POSCO currently operates the only Active Anode Material (AAM) facilities in South Korea. POSCO's natural graphite AAM plant in Sejong City produces 74ktpa, importing natural graphite from Chinese suppliers.⁸⁷ In December 2021, POSCO completed construction of its first synthetic graphite AAM facility in Blue Valley Industrial Complex, with a capacity of 8ktpa. On 31 January 2023, POSCO announced a 10ktpa expansion of the Pohang synthetic AAM plant.⁸⁸ Across both Pohang AAM plants, POSCO can supply up to 470,000 mid-range EVs annually (average 60kWh).

Synthetic graphite accounts for 83% of the global anode market, dominated by Chinese suppliers. Synthetic graphite remains the favoured anode material in EVs due to enhanced

⁸⁴ POSCO FM, [Expand High-Nickel Cathode Production Capacity by 46ktpa](#), 25 April 2023

⁸⁵ POSCO FM, [Future M Starts Construction of High-nickel NCA Cathode Material Plant](#), 28 April 2023

⁸⁶ POSCO FM, [FM Expands Investment in Battery Materials in Pohang to Build Precursor and Anode Material Plant](#), 3 May 2023

⁸⁷ Pulse, [FM Seeks to Reduce Reliance on China for Graphite for Anodes](#), 24 April 2023

⁸⁸ POSCO FM, [POSCO Expands the Production Capacity of Synthetic Graphite Anode Materials](#), 24 February 2023

changing speeds and extended lifespan from its high stability due to low material expansion and faster transfer of lithium-ions through its structure.

In December 2022, POSCO FM was awarded a long-term supply agreement with Ultium Cells for the supply of synthetic anode material.⁸⁹ The 8-year contract is valued at KRW 939.9 billion (US\$743m) from 2023-28, with POSCO exporting product from its expanding Pohang facility to the US venture between LGES and GM.

As part of the MoU signed with Huayou Cobalt in May 2023, the venture will invest a further KRW 500 billion (US\$395m) to build a second synthetic AAM production facility in Blue Valley Industrial Complex, Pohang. Just as POSCO has vertically integrated its cathode business, Future M has internalised its synthetic anode supply chain through its carbon material subsidiary, PMC Tech. Future M offtakes needle coke, a graphite by-product from dry distillation of coal-tar as part of PMC Tech's operations in steelmaking associated processes.

The vertical integration provides Future M's expanding synthetic AAM industry to mitigate supply chain procurement disruptions, and capitalises on the local production to ensure Ultium Cell's anodes are produced from free trade partners to receive Clean Vehicle Tax Credits under the IRA.

Future M: Global Expansion

In July 2022, Future M established Ultium CAM, a partnership with General Motors, seeking to establish battery material processing capacity in North America. In May 2023, Ultium CAM reached FID to construct an integrated precursor and cathode material complex in Becancour, Quebec Canada.⁹⁰ The facility has an estimated capital cost of C\$600m, and is expected to begin production in the first half of 2025.⁹¹ The product from the Ultium CAM facility will be used across North America's network of Ultium Cells battery manufacturing plants, leveraging the Canada-US FTA.

The joint venture attracted significant public financing from the Canadian Governments. In June 2023, the Governments of Canada and Quebec announced the contribution of C\$150m each to the integrated CAM facility.⁹² The public capital is facilitated through the Canadian Net Zero Accelerator initiative (NZAI) via the Strategic Innovation Fund. The NZAI is a C\$8bn investment vehicle to support large-scale industrial projects that contribute to Canada's goal of 40-45% GHG emissions reduction by 2030.⁹³

Across the Atlantic in August 2022, POSCO's venture with Huayou Cobalt, POSCO HY Clean Metal, completed construction of a rechargeable battery recycling plant in Poland. The facility will process black mass from retired battery packs to produce 7ktpa precursor material.⁹⁴ POSCO will operate the plant, licensing Korea's Sungeel HiTech Co.'s proprietary secondary battery recycling technology.⁹⁵ The joint venture signed an agreement with close partner, LG

⁸⁹ POSCO FM, [Contract with Ultium Cells for Artificial Graphite Anode Material Supply](#), 2 January 2023

⁹⁰ POSCO FM, [FM and GM to Expand EV Battery Supply Chain in North America](#), 2 June 2023

⁹¹ GM, [GM and POSCO FM Welcome Quebec and Canada Government Support for CAM Project](#), 29 May 2023

⁹² Bloomberg, [GM Secures Financial Support for an EV Battery Plant in Quebec](#), 30 May 2023

⁹³ Canada Gov, [Net Zero Accelerator Initiative](#), 29 May 2023

⁹⁴ POSCO FM, [POSCO Builds EV Battery Recycling Plant in Poland](#), 1 September 2022

⁹⁵ KED Global, [POSCO Builds EV Battery Recycling Plant in Poland](#), 26 August 2022

Chem, to collect 10,000tpa of scrap batteries from LG Energy Solutions' 35GWh battery manufacturing plant in Poland. The lithium, nickel, cobalt and manganese rich product will be exported to POSCO HY Clean Metal's new facilities in South Korea to be refined further into cathode material.

Across the expansion of Gwangyang, Pohang, and its growing global portfolio, Future M is seeking to scale its cathode capacity from 105ktpa in 2023 to 610ktpa by 2030. Future M has also upgraded its investment pipeline in precursor material, aiming to grow from 15ktpa in 2023 to 440ktpa by 2030. This would translate to an increase of proportion of in-house precursor production from 14% to 73% by 2030. In graphite anode material, Future M is seeking to grow from 82ktpa in 2023 to 320ktpa by 2030. Future M have also expressed desire to diversify its R&D into lithium metal anodes for silicon and solid-state batteries to enhance charging performance.

EcoPro

EcoPro is Korea's largest cathode producer. In 2022, EcoPro generated sales revenue of KRW 5.64 trillion (US\$4.46bn), a 275% growth from 2021.⁹⁶ **EcoPro BM**, its battery materials division, which is solely responsible for cathode production, achieved record sales in 2022, reaching KRW 5.36 trillion (US\$4.23bn), up 261% yoy and accounting for 95% of EcoPro's earnings. EcoPro has nurtured a strong partnership with Korea's cell manufacturers, with Samsung SDI its largest customer since 2012. In 2022, Samsung SDI accounted for KRW 3.18 trillion (US\$2.5bn) of EcoPro BM's revenue, a 265% surge in orders from 2021.⁹⁷ Off the back of surging demand from its customers, EcoPro BM forecasts KRW 10 trillion (US\$7.9bn) sales in 2023, and KRW 27 trillion (US\$21.3bn) by 2027.

In 2008, EcoPro BM constructed its first cathode material plant (CAM1) in Cheongju, Chungcheongbuk-do, South Korea. By 2015, Cheongju had completed four expansions (CAM1-4-(N)), aggregating to 30ktpa output capacity. In 2019, EcoPro completed CAM5 and CAM5-N, its first cathode plants outside of Cheongju, located in Yeongilman Industrial Complex, Pohang. CAM5 and CAM5-N have a combined capacity of 60kt across both plants. The Complex, referred to as Eco-Battery Pohang Campus, is now EcoPro's largest value chain cluster, and its primary investment jurisdiction.

In February 2020, EcoPro BM established a 60:40 joint venture with Samsung SDI, **EcoPro EM**, to construct dedicated cathode material plants for Samsung SDI's expanding footprint in Korea and Europe. In October 2021, EcoPro EM constructed its first CAM facility, CAM6, in the Eco-Battery Pohang Campus. At 36ktpa, it was the largest cathode plant in EcoPro's extended portfolio in 2021. In October 2022, EcoPro EM had completed its second joint facility, CAM7, in the Pohang Campus, boasting a record capacity of 54ktpa.⁹⁸

⁹⁶ EcoPro, [EcoPro to Exceed 5 trillion Won in Annual Sales by 2022](#), 3 February 2023

⁹⁷ KED Global, [EcoPro's Cathode Material Sales to Samsung More than Treble](#), 29 March 2023

⁹⁸ EcoPro, [Complete Construction of CAM7](#), 24 October 2022

Figure: Domestic CAM footprint for EcoPro BM and EcoPro EM as of 2023

Location	Div.	Facility	Product	Capacity	Time
Cheongju	BM	CAM1-4 + 4-N	Cathode	30kt	Op.
Pohang	BM	CAM5	Cathode	30kt	Op.
Pohang	BM	CAM5-N	Cathode	30kt	Op.
Pohang	EM	CAM6	Cathode	36kt	Op.
Pohang	EM	CAM7	Cathode	54kt	Op.
Pohang	EM	CAM8	Cathode	36kt	2024
Pohang	BM	CAM9	Cathode	54kt	2024

Source: Climate Energy Finance, using corporate announcements

In February 2022, EcoPro BM announced its investment pipeline of KRW 1.4 trillion (US\$1.11bn) for 2023, nearly double that of its growth capex of KRW 720 billion (US\$569m) in 2022.⁹⁹ In May 2023, EcoPro announced a KRW 473.2 billion (US\$374m) investment into Eco-Battery Pohang Campus, constructing its third EcoPro EM CAM facility with Samsung SDI (CAM8) and its sixth wholly-owned CAM facility (CAM9), set to finish construction by 2024. CAM8 will have a capacity of 36ktpa, with CAM9 matching CAM7 at 54ktpa.¹⁰⁰ From CAM1-7, EcoPro has a capacity of 180ktpa, expanding another 50% to 270ktpa with CAM8-9 by 2024.

EcoPro was the first Korean cathode producer to vertically integrate its mineral processing, metal refining and precursor material production for its CAM portfolio. In April 2017, the firm founded **EcoPro Materials** (originally EcoPro GEM), a value-add nickel and cobalt refining division which is used, in conjunction with imported lithium from China, to produce precursor materials. EcoPro Materials has two RMP (Raw Material Precipitate) plants, RMP1-2, which enriches nickel, cobalt and manganese to produce MHP (nickel and cobalt Mixed Hydroxide Precipitate) and MCP (Metal Composite Precipitate). RMP1 and RMP2 have a combined 20ktpa capacity of MHP.

Product from EcoPro Materials RMP1-2 is used in its two CPM (Cathode Precursor Material) plants. MHP and manganese sulfate solution undergo co-precipitation (with sodium (NaOH) and ammonia hydroxides (NH₄OH)) and Dry Solids Recovery to produce precursor-CAM (pCAM). Co-precipitation is the industry standard technique for high-nickel chemistries (NCM/NCA). EcoPro Materials' CPM1 and CPM2 have a combined capacity of 50ktpa of pCAM. EcoPro relies on Chinese suppliers to fill the gap between its pCAM and MHP facility. In December 2018, EcoPro signed a 5-year supply agreement with China's GEM, for the supply of 170kt of raw battery materials from 2019-2023.¹⁰¹ EcoPro Materials are continuing to scale its domestic capacity, currently constructing its third stage of plants, with RMP3 and CMP3 set to complete construction by 2024. RMP3 will have a capacity of 17ktpa MHP, and CMP3 capable of producing 30ktpa of pCAM.

⁹⁹ TheElec, [EcoPro BM to Double Cathode Investment This Year](#), 6 February 2023

¹⁰⁰ TheElec, [EcoPro BM Expands Spending to Increase Battery Cathode Production Capacity](#), 24 May 2023

¹⁰¹ Reuters, [China's GEM Signs 5-year Battery Material Supply Deal with EcoPro](#), 24 December 2018

EcoPro Innovation, is an EcoPro subsidiary responsible for lithium hydroxide production, used alongside EcoPro Materials pCAM material to internalise its supply chain for cathode production. EcoPro Innovation has the ability to produce hydroxide from salts (lithium carbonate from brine) and from minerals (hard-rock lithium spodumene). The division invested KRW 77.7 billion (US\$61m) into its first LHM mass-production plant, operating since October 2021. On 15 February 2023, Innovation announced the start of construction for its second LHM facility, matching LHM1’s capacity of 13ktpa.¹⁰² Combined, EcoPro will have 26ktpa capacity of LHM, with the firm expecting to ramp up sales from its Innovation division to KRW 2.1 trillion (US\$1.66bn) in 2024.

In March 2020, EcoPro founded a rechargeable battery waste recycling division, **EcoPro CnG**, in partnership with GEM, China’s largest battery recycling firm. In September 2020, EcoPro announced an investment of KRW 12 billion (US\$9.5m) to construct its first battery recycling plant (BRP1), licensing GEM’s technology in exchange for a stake in the project.¹⁰³ The facility was completed in 2021. EcoPro CnG is currently building its second recycling plant, BRP2, also in Eco-Battery Pohang Campus.

Figure: Footprint for EcoPro BM subsidiaries in Pohang as of 2023

Location	Div.	Facility	Product	Capacity	Time
Pohang	Mat.	RMP1	MHP	10kt	Op.
Pohang	Mat.	RMP2	MHP	10kt	Op.
Pohang	Mat.	CPM1	Precursor	24kt	Op.
Pohang	Mat.	CPM2	Precursor	26kt	Op.
Pohang	Mat.	RMP3	MHP	17kt	2024
Pohang	Mat.	CPM3	Precursor	30kt	2024
Pohang	Inno.	LHM1	Li. Hydroxide	13kt	Op.
Pohang	Inno.	LHM2	Li. Hydroxide	13kt	2024
Pohang	CnG	BRP1	Recycling	8kt	Op.
Pohang	CnG	BRP2	Recycling	8kt	2024

Source: EcoPro Company Summary ¹⁰⁴

In 2023, EcoPro BM expanded its investment pipeline outside of Pohang, forming multiple joint ventures to scale across Korea, Europe and North America.

In March 2023, EcoPro BM established a joint venture with Korea’s SK On and China’s GEM Co. to construct a 50ktpa precursor material plant in the Saemangeum National Industrial Complex, North Jeolla Province.¹⁰⁵ The new partnership, GEM Korea New Energy Materials

¹⁰² KED Global, [EcoPro Boosts Raw Material Plant for Cathode Materials](#), 15 February 2023

¹⁰³ TheElec, [EcoPro to Invest 12 billion won for Battery Recycling Business](#), 15 September 2020

¹⁰⁴ EcoPro, [Brochure - English Version](#), 30 March 2023

¹⁰⁵ EcoPro, [Establish JV Between EcoPro, SK On and GEM for Precursor Production](#), 28 March 2023

Co., will invest a total of KRW 1.21 trillion (US\$956m) into the project, with construction expected to finish by 2024. pCAM output will feed into EcoPro BM's CAM facilities to supply SK On's global cell manufacturing network. The pCAM facility will power 300,000 EVs with SK On battery packs.¹⁰⁶

In December 2021, EcoPro BM announced its plan to invest KRW 970 billion (US\$766m) in a cathode material plant in Debrecen, Hungary.¹⁰⁷ On 21 April 2023, EcoPro announced it had commenced construction of the 108ktpa CAM facility, EcoPro's first facility outside of Korea, expected to complete construction in 2024, with mass production by 2025.¹⁰⁸ The facility will supply cathode products to Samsung SDI's cell manufacturing plant in Göd, Hungary.¹⁰⁹ The new plant will be able to supply sufficient cathode material to produce 1.35 million EVs annually using Samsung SDI battery packs.

EcoPro BM announced its plan to spend KRW 2.8 trillion (US\$2.2bn) in cathode production in North America and Europe by 2026. In July 2022, SK On announced its plan to jointly invest in a cathode material production facility in North America, in partnership with EcoPro BM and Ford.¹¹⁰ In October 2022, the joint venture (EcoCAM Canada) announced it would construct the US\$704m facility in Becancour, Quebec (the same location as Ultium CAM – POSCO Future M and GM's cathode production joint venture).¹¹¹ The EcoPro BM facility will supply cathode materials to BlueOvalSK, the cell manufacturing JV between Ford and SK with plants across Tennessee and Kentucky, US. In November 2022, Bloomberg reported EcoCAM Canada was on track to receive financial incentives from the federal and provincial governments of Canada, however nothing has been confirmed as of June 2023.¹¹²

¹⁰⁶ KED Global, [SK On, EcoPro, China's GEM to Jointly Build Precursor Factory](#), 23 March 2023

¹⁰⁷ KED Global, [Korea's EcoPro BM to Build First Overseas Plant in Hungary](#), 10 December 2021

¹⁰⁸ EcoPro, [First Domestic Cathode Materials Company to Enter Europe](#), 27 April 2023

¹⁰⁹ KED Global, [EcoPro Sets Sights on Europe with \\$286m Cathode Plant in Hungary](#), 24 April 2023

¹¹⁰ SK Innovation, [SK On Jointly Invest in Cathode Material Production Facility with Ford and EcoPro BM](#), 22 July 2022

¹¹¹ KED Global, [EcoPro BM to Build Battery Materials Plant in Canada](#), 31 October 2022

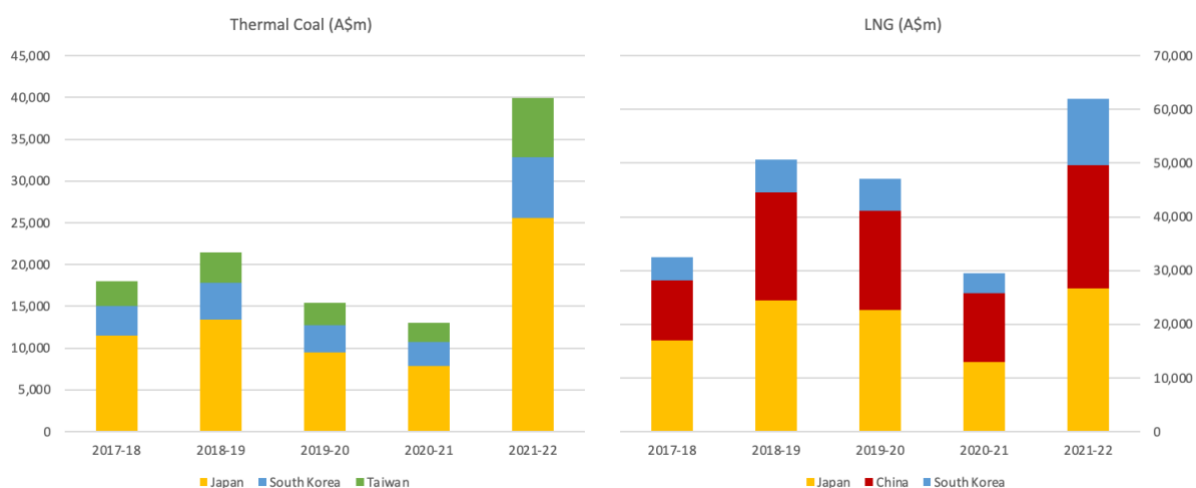
¹¹² Bloomberg, [Ford in Talks with Korean Firms to Build Cathode Plant in Quebec](#), 4 November 2022

Section 4. Australia and Korea’s Current Trade, Policy and Joint Investment

South Korea is a key trade partner with Australia, third behind China and Japan. Since the Korea-Australia Free Trade Agreement (KAFTA) of 2014, relationships, investment and collaboration have all grown significantly, and there is a huge opportunity for Australia and South Korea to leverage our respective geopolitical, investment, mining, refining and manufacturing strengths to jointly seize the once in a lifetime opportunity to leverage the US IRA in batteries and EVs.

In 2021-22, South Korea represented 6.5% (\$68.7bn) of Australia’s total trade and imported \$48.8bn from Australia.¹¹³ In 2021-22 resource and energy exports (including iron ore, coking and thermal coal and LNG) contributed \$33bn to Australia’s exports to Korea, third behind China (\$140bn) and Japan (\$54bn).¹¹⁴ South Korea was Australia’s second-largest export destination for thermal coal in 2021-22, importing \$7.3bn.¹¹⁵ Over the same period, South Korea imported \$12.3bn of LNG exports from Australia, up 230% from the prior year.

Figure: Top Export Destinations for Australian Energy Industries (\$m)



Source: Office of the Chief Economist, CEF calculations

South Korea has become a vital trade partner for Australia’s resource and energy sector. Korea is Australia’s third-largest export destination for metallurgical coal and iron ore, the vital components for steel manufacturing.

Over the last financial year, Australia exported \$8.9bn in iron ore and \$10.1bn in metallurgical coal to South Korea, with coking coal export value to Korea growing over 230% from the previous year. POSCO is the largest steel producer in South Korea and was the sixth-largest steel producer globally in 2022.

As the economy expands its footprint across new energy materials and electrification supply chains, Australia is well positioned to be a leading supplier for aluminium, zinc and critical

¹¹³ DFAT, [Republic of Korea Country Brief](#)

¹¹⁴ OCE, [Resources and Energy Quarterly March 2023](#), 3 April 2023

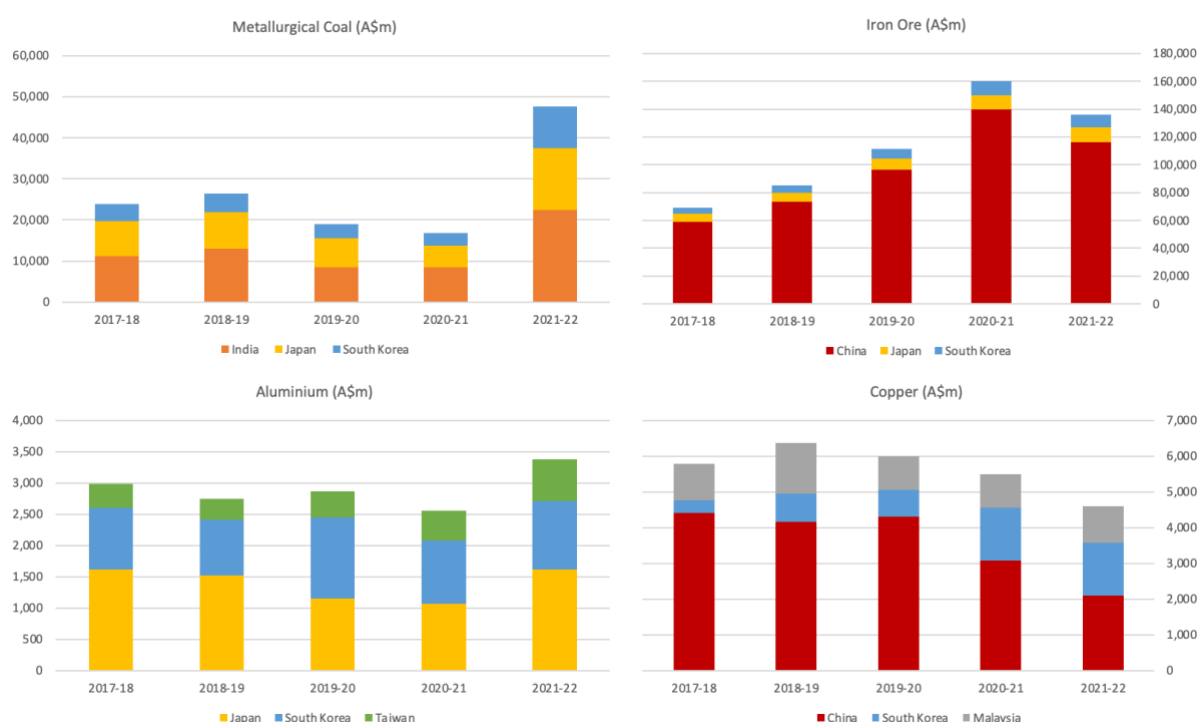
¹¹⁵ OCE, [Resources and Energy Quarterly March 2023](#), 3 April 2023

minerals for South Korea. In 2021-22, \$1.1bn in aluminium exports were shipped to South Korea, making it the second-largest export destination, behind Japan.

Korea is also the second-largest export destination for Australian copper, behind China. In 2021-22, copper exports to Korea grew to near \$1.5bn, closing the gap to Chinese imports, which fell almost \$1bn in 2021-22 to \$2.1bn.

For other critical minerals, China dominates Australia’s export market. In 2021-22, Australia’s lithium exports grew to \$5.3bn, with forecasts expecting 2022-23 earnings to more than triple to \$18.6bn. China accounts for over 96% of all Australian lithium exports, with South Korea the third-largest destination at 0.9% (behind Belgium at 2.3%).

Figure: Top Export Destinations for Key Australian Industries (\$m)



Source: Office of the Chief Economist, CEF calculations

South Korea is Australia’s fourth-largest trading partner and third-largest export market, with the two economies strengthening their relations across trade, diplomacy and defence over the past few decades. Australia’s partnership with Korea goes back more than 7 decades to the Korean War and has been enhanced by multiple bilateral free trade agreements in recent years.

The **Korea-Australia Free Trade Agreement (KAFTA)** is a comprehensive bilateral agreement signed in December 2014.¹¹⁶ The FTA protects and enhances each nation’s competitive position in global trade, eliminating tariffs and substantially benefiting Australia’s trade in scale and diversification, encouraging collaboration and co-investment.

The KAFTA contains a detailed bilateral agreement on the mutually beneficial cooperation between Australia and Korea in the energy and mineral resources sector (Chapter 16:

¹¹⁶ DFAT, [Korea-Australia Free Trade Agreement](#)

Cooperation, Section B: Energy and Mineral Resources).¹¹⁷ Under the KAFTA, cooperative activities between the public and private sectors of energy and mineral resources across both nations include the joint research and development, exchange of academic and scientific advancements, exchange of experts and technicians related to the exploration, extraction, processing, transportation and use of energy and mineral resources, including energy efficiency measures and measures relating to climate change.

The KAFTA further strengthens the development of energy and mineral industries, promoting mutually beneficial trade and foreign investment, the transfer of valuable information regarding advancements in critical infrastructure, tenders, mining projects, and the maintenance of stable, equitable and mutually favourable conditions for investors.

The **Regional Comprehensive Economic Partnership (RCEP)** is an FTA that complemented and enhanced the trade relationships between Australia and 14 Indo-Pacific economies.¹¹⁸ Implemented in January 2022, the RCEP is the world's largest FTA by GDP from ASEAN, China, Japan, India and New Zealand. In February 2022, South Korea entered into the RCEP.

In March 2023, Western Australia (via the Minerals Research Institute) and South Korea (via Institute of Geoscience and Mineral Resources (KIGAM)) formalised an MoU for the exchange of scientific and technical knowledge across the critical minerals mining value chain.¹¹⁹ WA Minister for Mines and Petroleum, Bill Johnston, expressed the critical importance of the MoU for developing a strong connection for Australia's battery chemical industry in partnership with Korea's established industry.

The policy framework with clear goals for strengthening our trade relationship with South Korea has been imperative to diversifying our export markets, and opening channels for foreign investment into Australia's resource and energy industries, and encouraging collaboration and co-investment, both in Australia and South Korea.

4.1 Export Credit Agencies and strategic public sector investments

In 2021, Australia received \$29.8bn in direct investment by South Korea, making it Australia's 17th largest direct foreign investor.¹²⁰ Global collaboration between Export Credit Agencies (ECAs) has been a crucial vehicle for driving capital into infrastructure, energy and mining projects.

Climate Energy Finance notes the Australian concept of leaving it to the free market is outdated when it comes to the rapidly accelerating global energy transition, particularly when it comes to the US IRA, the EU NZIA, the Japanese GX Roadmap, India's PLI and foremost - competing with China, which is probably a decade ahead of the west when it comes to comprehensively investing in all zero emissions industries of the future.

CEF is calling for a A\$100bn of public strategic capital investment across Australian clean tech, to crowd-in A\$200-300bn.¹²¹ CEF sees the role of Australia's ECA, Export Finance Corporation

¹¹⁷ DFAT, [Korea-Australia Free Trade Agreement Official Documents](#)

¹¹⁸ DFAT, [Regional Comprehensive Economic Partnership](#)

¹¹⁹ WA Gov, [South Korean Agreement to Bolster WA's Battery Chemical Industry](#), 15 March 2023

¹²⁰ DFAT, [Republic of Korea Country Brief](#)

¹²¹ CEF, ["Truly momentous:" Solar is changing everything, and Australia must seize the occasion](#), 14 June 2023

(EFA), as well as National Infrastructure Fund (NAIF), Clean Energy Finance Corporation (CEFC), ARENA, Future Fund and the soon to be established A\$15bn National Reconstruction Fund as public financial institutions that need to work strategically to crowd-in capital from Australia's A\$3.4 trillion of private superannuation, alongside investments by strategic trading partners such as [South Korea's Korea Zinc](#) in green zinc refining at Townsville, [Norway's Yara](#) on green ammonia, the [UK's BP](#) in renewable energy, [China Baowu Group](#) on Pilbara green iron and [Albemarle US](#) on Australian lithium refining.

In December 2022, POSCO announced it would invest \$28bn into green hydrogen and \$12bn in green steel as part of a \$40bn investment strategy to establish Australia as an export-base for POSCO's heavy industry.¹²² If realised, it would be one of the largest foreign direct investments in Australia's recorded history.

In February 2022, EFA and Korea Trade Insurance Corporation (K-SURE) signed an MoU to strengthen their joint financing capacity across critical minerals, low-emission technologies and regional infrastructure.¹²³ K-SURE and EFA have emphasised the impact bilateral agreements will have in boosting critical minerals supply chains across the Indo-Pacific and enhancing cooperation across information and expertise exchange, mineral exploration and new investment opportunities.

Korean battery value chain firms are expanding their Australian footprint, acquiring strategic equity in value-added critical minerals projects in the development pipeline to feed into its rapidly growing battery chemical processing industry. Korean firms are leveraging Korea's Ministry for Trade, Industry and Energy (MOTIE) power and financial support to accelerate Korea's reach globally.

4.2 Korean Collaboration with Australian Corporates

Australia and Korea have some strong collaborations well underway in the critical minerals, metals and lithium mining and refining sectors, as illustrated by Queensland Pacific Metals, Pilbara Minerals, Liontown Resources, Arafura Rare Earths, Renascor Resources, First Quantum Minerals, Australian Strategic Metals and Korea Zinc's Sun Metals.

Queensland Pacific Metals

In June 2021, POSCO acquired a 3.2% stake in **Queensland Pacific Metals** (QPM) for US\$4.5m, alongside close-partner LG Energy Solutions (which acquired a 7.5% stake at US\$10.5m).¹²⁴ As part of the investment, POSCO and LGES gained binding off-take agreements for a combined 10kt contained nickel and 1kt contained cobalt through the shipment of value-added nickel and cobalt sulphates from QPM's Townsville Energy Chemicals Hub (TECH) project.

Importing high-grade laterite ore from New Caledonia, the TECH project will provide nickel and cobalt sulphates as precursor nickel products for high-nickel cathodes. QPM has secured 100% of project life nickel and cobalt off-take agreements with General Motors, LGES and

¹²² Global Australia, [Steelmaker POSCO Plans \\$40bn Hydrogen Investment](#), December 2022

¹²³ EFA, [EFA Strengthens Ties with KSURE](#), 8 February 2022

¹²⁴ Mining Technology, [LG Energy and POSCO to Pick \\$15m Stake in EV Battery Material Supplier QPM](#), 8 June 2021

POSCO. The project will be funded by various domestic and foreign export credit agencies. Following the investments made by LGES and POSCO, K-Sure (South Korea's export credit agency under MOTIE) established an MoU with EFA to provide joint financing of Australian projects, with EFA expected to commit \$250m to the project. NAIF is in discussions with QPM to provide up to \$250m in additional funding.

Following the decision from General Motors (GM) to invest up to US\$69m into QPM for a 15-year nickel and cobalt supply deal, to supply GM's North American expanding operations,¹²⁵ Export Development Canada announced a non-binding letter of support for the provision of debt funding for up to \$400m to accelerate development.¹²⁶ QPM is a clear example of the public debt support for foreign investors seeking to bolster supply chains and onshore manufacturing capacity.

Pilbara Minerals

Pilbara Minerals is one of the largest lithium miners in Australia, operating the Pilgangoora lithium mine in WA. Pilbara Minerals has approved capacity expansion investments to increase its spodumene capacity to 1Mtpa, from 580ktpa in 2022. An in-depth review of Pilbara Minerals latest growth capex can be found in CEF's April 2023 [Australian Lithium Export Market Review](#).

In October 2021, POSCO formed a joint venture with Pilbara Minerals to jointly develop a US\$600-650m LHM facility in the POSCO Value Chain Cluster of Gwangyang, South Korea.¹²⁷ The 18:82 partnership (favouring POSCO) would offtake 315ktpa of spodumene concentrate from Pilbara's expanding Pilgangoora operations, to produce 43ktpa of value-added LHM as feedstock into POSCO Future M's expanding battery chemical processing operations across Gwangyang and Pohang.

To accelerate the development of the project, in February 2023, Korea's Export-Import Bank (KEXIM) and the Korea Development Bank provided a US\$460m debt facility, to commission Train I (21.5ktpa) by 4QCY2023.¹²⁸ The Korean public capital would cover the forecast remaining capital required to complete the facility.

Australian Strategic Metals

ASX-listed Australian Strategic Metals (ASM) is an emerging vertically integrated producer of value-added rare earth products across Australia and South Korea, a perfect illustration of the collaboration and partnership opportunities the US IRA could unlock.

ASM has a proposed investment into mining, separation and refining of rare earths and critical minerals (neodymium, praseodymium, dysprosium, terbium, zirconium, hafnium, niobium) at Dubbo, NSW, with the aim to then ship the metal oxides and mixed chlorides to ASM's **Korean Metals Plant** at Ochang Foreign Investment Zone for further refining into NdPr metals and Copper Titanium (CuTi) alloy for use in Korea and NdFeB alloy for sale into the US.¹²⁹

¹²⁵ AFR, [General Motors Takes a Big Stake in Queensland Nickel Play](#), 12 October 2022

¹²⁶ QPM, [Debt Financing Update](#), 6 March 2023

¹²⁷ Pilbara Minerals, [Joint Venture with POSCO to Participate in Downstream Lithium Chemicals Facility](#), 26 October 2021

¹²⁸ Pilbara Minerals, [POSCO Pilbara Downstream JV Secures Debt Facility](#), 27 February 2023

¹²⁹ ASM investor presentation, [ASM development update](#), June 2023

In December 2021, ASM signed a Joint Statement of Cooperation with the Korean Mine Rehabilitation and Resource Corporation (KOMIR), the renamed Korean Resources Corporation (KORES), to enable the supply of critical minerals and metals into Korea. In May 2022, ASM raised US\$15m in new equity from KCF Energy Co., a Korean consortium made up of Cerritos Holdings, Polo Equity Partners and ACE Equity Partners, with the intent to secure a significantly larger US\$280m equity investment from a new strategic investor.¹³⁰

ASM's **Dubbo Project** should create 1,000 jobs during construction and 270 ongoing local jobs. The proposed A\$1.7bn investment is underpinned by a June 2021 A\$200m letter of financial support from EFA.¹³¹ In September 2022, ASM signed an MoU with the Korean Development Bank to establish a rare earths supply chain.¹³² In November 2022, ASM completed a A\$41m equity raising in support of the Dubbo Project. December 2022 saw ASM awarded \$10.5m in grant funding from the NSW government and in May 2023, received a \$6.5m grant from Australian Government under Tranche 2 of the Critical Minerals Development Program (CMDP).¹³³ In January 2023, ASM awarded the engineering, procurement and construction definition work (EPCD) to Hyundai Engineering Co., Ltd. ASM expects to finalise bankable offtakes and equity from strategic partners and/or governments in 2HCY2023 before going to a FID in 2HCY2024 and awarding the EPC contract. Given the rapid decarbonisation of the Australian electricity grid, ASM targets powering the mine and refinery with 100% renewable energy.

April 2023 saw ASM sign a binding agreement with Vietnam Rare Earth Company (VTRE) for the purchase of rare earth oxides from Vietnam to be used as feedstock at ASM's Korean Metals Plant.¹³⁴

Korea Zinc's Sun Metals

Sun Metals Zinc Refinery is located in Townsville in North Queensland. The refinery was built in 1996 by Sun Metals, an Australian subsidiary of Korea Zinc Company Limited, the largest zinc, lead and silver producer in the world.¹³⁵ Sun Metals produces a Special High Grade of Zinc metals and sulphuric acid as a secondary product. Sun Metals has made a commitment to power its entire operations with 80% renewable electricity by 2030 (100% by 2040). In November 2020, Sun Metals joined the global RE100 initiative.

Liontown Resources

Liontown Resources is developing the \$895m Kathleen Valley lithium project in WA. In November 2021, Liontown announced a Downstream Scoping Study to develop a 3-train LHM facility to value-add its Kathleen Valley operations. The proposed 86.4ktpa facility (28.8ktpa per train) has an estimated capital cost of ~ \$1.5bn.¹³⁶

¹³⁰ ASM press release, [USD 15 million Subscription Agreement at AUD 8.90 per ASM share](#), 16 May 2022

¹³¹ ASM press release, [Export Finance Australia issues letter of support for the Dubbo Project](#), 28 June 2021

¹³² ASM press release, [ASM signs MOU with KDB for rare earths supply chain](#), 23 September 2022

¹³³ ASM press release, [ASM awarded \\$6.5 million Federal Government grant for Dubbo Project](#), 18 May 2023

¹³⁴ ASM press release, [ASM signs binding agreement with Vietnam Rare Earth Company \(VTRE\) for metals plant feedstock supply](#), 30 April 2023

¹³⁵ Sun Metals, [Our Company](#)

¹³⁶ Liontown Resources, [DFS and Updated DSS](#), November 2021

In May 2022, LG Energy Solutions formalised a binding offtake agreement for 150ktpa of spodumene concentrate from Kathleen Valley over a 5-year term, with an option to extend a further 5 years.¹³⁷ The off-take agreement was one of three foundational partnerships signed by Liontown Resources, with Tesla and Ford signing the remaining available contracts.

Arafura Rare Earths

Arafura is developing the Nolans Project in the Northern Territory, a \$1.6bn rare earths mine and processing (beneficiation, extraction and separation) operation.¹³⁸ A single site facility that will produce rare earth oxides and phosphate from the Nolans Bore deposit, a region enriched with magnet feed rare earths, neodymium and praseodymium (NdPr). The Nolans Project is expected to produce 4.3ktpa of NdPr oxide over 4 decades, with production expected to commence in 2025, subject to financing, construction and commissioning of the project remaining on-track.¹³⁹

In November 2022, Arafura signed its cornerstone offtake agreement with Korea's Hyundai Motor Co. and Kia Co. Arafura will supply 1.5ktpa of NdPr oxide over a 7-year term, with option to extend a further 5-years, representing 40% of the Project's annual output available for long-term contracts.¹⁴⁰ As part of the agreement, a non-binding Heads of Agreement (HoA) was signed for potential strategic investment into the project by Hyundai Motor Co. and its affiliates.

Arafura has significant financial support from international export credit agencies for the Nolans Project. In March 2023, Arafura announced it received a non-binding letter of in-principle support from Germany's Export Credit Agency (Euler Hermes Aktiengesellschaft) for an untied loan guarantee of up to US\$600m.¹⁴¹ In April 2023, Arafura announced the offtake agreement with Germany's Siemens Gamesa Renewable Energy, a global wind turbine manufacturer. The partnership will commence in 2026 over a 5-year term, with a 2-year extension option available.¹⁴² NdPr supplied to Siemens will be processed into permanent magnets and powertrains in Germany.

Northern Australia Infrastructure Facility (NAIF) has increased its support for the Nolans Project, boosting its tranche of project finance from \$100m to \$150m. NAIF advised Arafura the project has passed the strategic assessment phase, and is subject to approval from the NAIF board.¹⁴³ In December 2022, Arafura announced a Tranche 1 placement of \$121m, that brought Gina Rinehart in as a 10% shareholder.

Renascor Resources

Renascor is developing the Siviour Graphite Project, a vertically integrated Purified Spherical Graphite (PSG) operation (mine, concentrator and battery anode material (BAM) facility) in

¹³⁷ Liontown, [Liontown and LGES Execute Binding Offtake Agreement](#), 2 May 2022

¹³⁸ Arafura, [Nolans Project Update](#), 11 November 2022

¹³⁹ The Australian, [Arafura Hits Crescendo Following Cornerstone REE Offtake Deal with Hyundai and Kia](#), 8 November 2022

¹⁴⁰ Arafura, [Cornerstone NdPr Offtake Agreement with Hyundai and Kia Corporation](#), 7 November 2022

¹⁴¹ Arafura, [Additional Australian and International Credit Agency Support for Nolans Project](#), 29 March 2023

¹⁴² Arafura, [NdPr Offtake Agreement with Global Wind Turbine Manufacturer Siemens Gamesa Renewable Energy](#), 11 April 2023

¹⁴³ Arafura, [Additional Australian and International Credit Agency Support for Nolans Project](#), 29 March 2023

South Australia. In February 2022, to accelerate the development of the Siviour Graphite Project, Renascor received the conditional support for a \$185m loan from the \$2bn Critical Minerals Facility, administered through EFA.¹⁴⁴ The Siviour Project's downstream BAM study is expected to be complete by July 2023, with FID later in 2023.

In August 2021, Renascor entered into a non-binding offtake MoU with POSCO for the supply of 20-30ktpa PSG as feedstock for its expanding Active Anode Material capacity across South Korea.¹⁴⁵ The agreement provides the scope for possible equity investment by POSCO into Renascor, with discussions currently ongoing. The agreement represents up to 100% of Siviour's Stage 1 capacity.

Global diversification of PSG supply is of critical importance to emerging battery anode producers outside of China. 100% of PSG is currently produced in China. All anode producers (including South Korea and Japan) are dependent on PSG imports from China.

Renascor estimates Chinese producers have average operating costs of ~ US\$2,000/t PSG, with graphite concentrate feedstock the significant cost input in the manufacturing process. Renascor's integrated pipeline, from mine to refined product in South Australia, will be able to provide globally competitive PSG supply at US\$1,989/t.¹⁴⁶ Benchmark Mineral Intelligence expects PSG demand to surge at a CAGR of 29% through to 2030.

First Quantum Minerals

FQM is a Canadian mining company with global nickel, copper, cobalt and gold assets. In 2010, FQM purchased Ravensthorpe Nickel, a decommissioned mine in Western Australia. In early 2020, FQM restarted operations, creating over 350 jobs. In May 2021, POSCO acquired a 30% share of the Ravensthorpe nickel project from FQM for US\$240m.¹⁴⁷ The contract also included an offtake contract for 7.5ktpa of contained nickel in Mixed Hydroxide Precipitate (MHP) from 2024 onwards. Ravensthorpe is ramping up production to 30ktpa of contained nickel, with 2022 production reaching 22ktpa.¹⁴⁸

In January 2023, Ravensthorpe announced the proposal for an 18-20MW wind farm to reduce reliance on diesel generators. The WA nickel operation is powered from waste heat in steam turbines as sulphur is burned to generate sulphuric acid as part of the nickel process. Diesel generation is used as stand-by power. However, FQM's WA Regional Manager, Gaven Ashley, said diesel generators are being used more frequently, triggering the motivation to explore how FQM can offset that.¹⁴⁹

¹⁴⁴ Renascor, [Conditional Approval Received from Australian Government](#), 4 February 2022

¹⁴⁵ Renascor, [Strategic Cooperation and Offtake Agreement with POSCO](#), 25 August 2021

¹⁴⁶ Renascor, [Australian Supply from Renascor's Battery Anode Material Project](#), 3 May 2023

¹⁴⁷ Australian Mining, [POSCO Acquires Ravensthorpe Stake from First Quantum](#), 20 May 2021

¹⁴⁸ FQM, [2022 Annual Report](#)

¹⁴⁹ ABC, [Ravensthorpe Nickel Operation Becomes Latest WA Mine to Push Ahead with Wind Power Switch](#), 27 January 2023

Section 5. National Resource Security and Competing Investment Markets for Australia

Australia has obvious competitive advantages in terms of renewable energy powered refining of upstream critical minerals and lithium supplies for battery manufacturing. However, the global energy transition's acceleration has meant an investment and export race is now well underway. South America's lithium triangle of Chile-Argentina-Bolivia and Indonesia are global-scale suppliers, and South Korea is well established to diversify its supply channels. Australia has lithium hydroxide production cost and embodied decarbonisation advantages.

Latin America

Chile is the world's 2nd largest lithium producer, behind Australia, but holds the 3rd largest lithium resource, at 9.8Mt in 2022, according to the US Geological Survey.¹⁵⁰ Australia has a resource of 7.3Mt in 2022. In April 2023, Chile announced its **National Lithium Strategy**, a reformation of its lithium industry through public-private partnerships.¹⁵¹ The strategy is aimed to extract the value of Chile's key industry to boost sovereign wealth and economic development as it transitions to a decarbonised economy.

The National Lithium Strategy would form a public entity, the National Lithium Company, that would require a controlling ownership share in lithium operations to offer contracts to private firms seeking to continue or expand operations. Chile's SQM and US Albemarle own the largest lithium operations in Chile's vast Atacama salt flats. The national reform would not terminate current contracts, however urges private firms to engage in state participation before expiration. SQM's current operating contract is set to expire in 2030, and Albemarle in 2043.¹⁵²

Chile is part of the American lithium triangle; a region of salt flats across Chile (Atacama), Argentina (Olaroz and Hombre Muerto) and Bolivia (Uyuni) rich with lithium reserves. According to the USGS, the top lithium resources are in the lithium triangle (Bolivia: 21Mt, Argentina: 19Mt, Chile: 9.8Mt).¹⁵³

Latin America is a critical resource for Korea's battery value chain.

In January 2021, **LG Energy Solutions** entered into a long-term supply agreement with SQM through 2029. The mammoth contract positions LGES as SQM's largest customer, off-taking just under 80% of SQM's annual production.¹⁵⁴ In May 2023, Korea's MOTIE met with the Chilean government for the first time since October 2021. Korea and Chile established its FTA in 2003, the first FTA signed by Korea. Since then, bilateral trade has grown over 400%. The new focus of negotiations in May between Korea and Chile were on enhancing the bilateral cooperation across supply chains, energy, resource cooperation and digital trade.¹⁵⁵

¹⁵⁰ USGS, [Mineral Commodity Summaries 2023](#), 31 January 2023

¹⁵¹ Chile Gov, [National Lithium Strategy](#), April 2023

¹⁵² Reuters, [Chile Plans to Nationalise its Vast Lithium Industry](#), 21 April 2023

¹⁵³ USGS, [Mineral Commodity Summaries 2022 - Lithium](#)

¹⁵⁴ Electrive, [LG Energy Solutions Becomes SQM's Biggest Lithium Client](#), 11 January 2021

¹⁵⁵ MOTIE, [Korea and Chile Restart Negotiations for Upgrading FTA](#), 26 May 2023

In 2018, POSCO Holdings' subsidiary, **POSCO Argentina**, acquired rights to a Salar del Hombre Muerto lithium region from Australia's Galaxy Resources (merged with Orocobre to form Allkem in 2021) for US\$280m.¹⁵⁶ In March 2022, Reuters reported POSCO Argentina will invest US\$4bn into the Hombre Muerto project through 2028.¹⁵⁷

At the end of March, POSCO announced the start of construction of Phase 1 brine and LHM plant, announcing the start of the 'Ombre Muerto Lithium Salt Lake Development Project', totalling US\$830m.¹⁵⁸ Phase 1 plans to have an output of 25ktpa from a new lithium hydroxide refinery, with construction expected to finish 1H2024. On 18 October 2022, POSCO announced the start of Phase 2 construction, a further 25ktpa LHM facility estimated to cost US\$1.09bn.¹⁵⁹ In the announcement, POSCO confirmed Stages 3-4 were progressing rapidly to quadruple annual LHM output to 100ktpa.

POSCO Argentina is a vital trade network for Korea's domestic cathode production growth. In January 2023, K-SURE, Korea's export credit agency, announced a US\$520m financing package for POSCO Holdings for the development of the Ombre Muerto Lithium Salt Lake Development Project.¹⁶⁰ K-SURE President, Lee In-ho, expressed that the involvement would be a great contribution to securing further stable supply of lithium to Korea, at a time when the world is fiercely competing behind the scenes to establish a global supply chain." In the same month, in partnership with K-SURE, Citibank Korea announced a syndicated loan of US\$412m for the Argentina project.¹⁶¹

South Korean firms have demonstrated how critically important is the stable, long-term lithium supply for its domestic manufacturing growth and profitability. However, a June 2023 report published by McKinsey also highlighted Australia's potential in global lithium markets, highlighting Australia's opportunity to extract the value of rapid demand growth to become the world's lowest cost supplier of value-added lithium midstream products.¹⁶²

Australia produced almost half the extracted lithium globally in 2022, exported virtually entirely to China in an almost entirely unprocessed state, as discussed in the previous section. However, Australia has now entered the value-added lithium hydroxide industry, establishing 3 world-class LHM facilities in WA, as discussed in Climate Energy Finance's [critical minerals report](#), of March 2023.

All of Australia's LHM facilities are integrated with spodumene concentrate supply, sourced from Greenbushes and Mt Holland mines across WA. Integrated hard-rock mineral supply to produce hydroxide is the critical competitive advantage of Australia's industry compared to competing jurisdictions across Latin America, which convert lithium carbonate from brine. McKinsey's analysis shows integrated hard-rock producers of hydroxide generate 70-85% margins, significantly higher than the 40-60% margins of non-integrated refiners.

¹⁵⁶ Electrive, [POSCO Confirms Plans for Lithium Plant in Argentina](#), 16 December 2021

¹⁵⁷ Reuters, [South Korea's POSCO to Invest \\$4bn in Lithium Project in Argentina](#), 22 March 2022

¹⁵⁸ POSCO, [POSCO Holdings Begins Construction of Saltwater Lithium Plant in Argentina](#), 31 March 2022

¹⁵⁹ POSCO, [POSCO Holdings to Invest in Salt Water Lithium Factory in Argentina](#), 18 October 2022

¹⁶⁰ Global Trade Alert, [K-SURE Provides Financing to Support POSCO Holdings Construction of Lithium Extraction Facility in Argentina](#), 27 January 2023

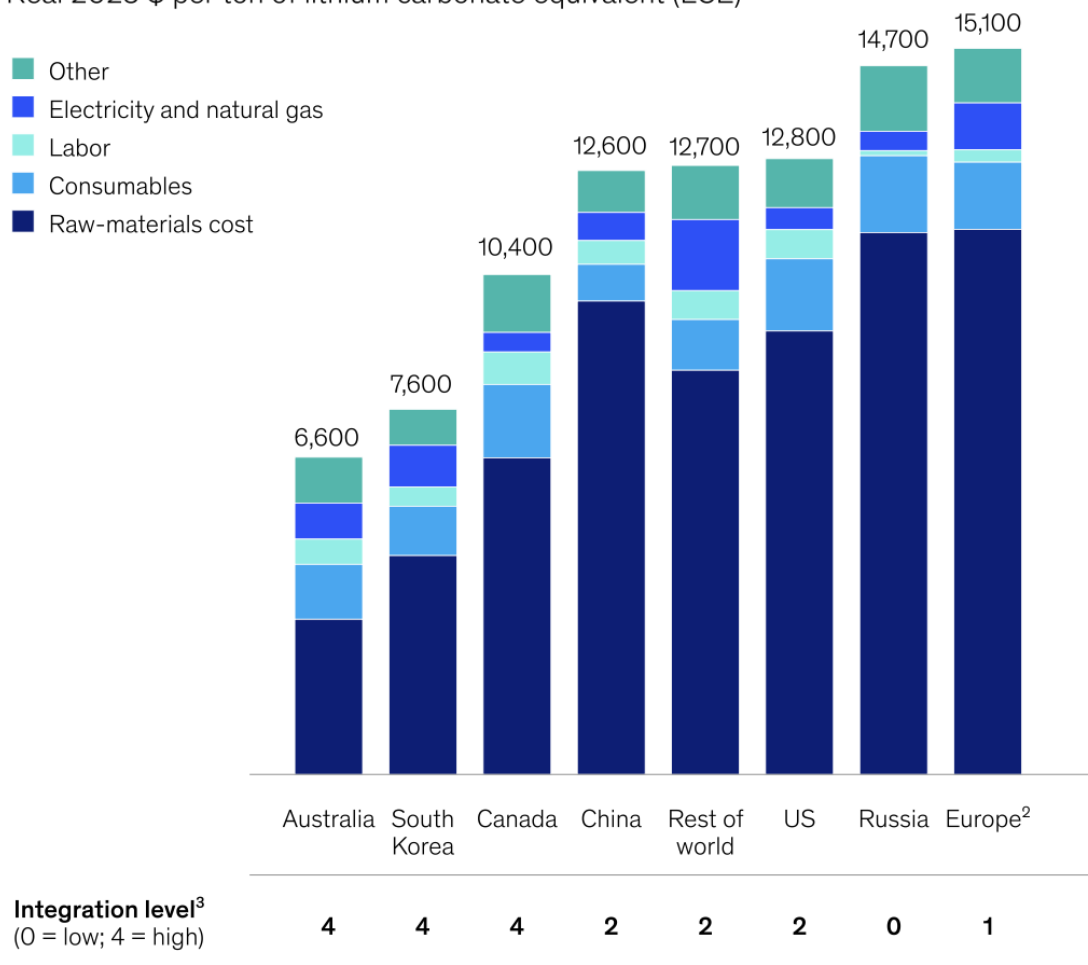
¹⁶¹ KED Global, [Citibank Korea Provides \\$412mn to POSCO for Argentine Business](#), 6 February 2023

¹⁶² McKinsey, [Australia's Potential in the Lithium Market](#), 9 June 2023

Australia’s integrated refiners could produce lithium hydroxide at US\$6,600/t of LCE (lithium carbonate equivalent) according to Mckinsey’s economic modelling, significantly lower than China’s US\$10,400/t. South Korea and Canadian refiners would have costs ~ 24-51% higher than that of Australia, given Australia’s geological resources. Compared to the global market average, Australian refiners could produce hydroxide **52% cheaper** than the rest of the world by 2030.

Figure: Australia as the World’s Lowest-Cost Value-Added Lithium Producer Globally:

Weighted average cost breakdown for lithium hydroxide (LiOH) refining facilities, 2030,¹
Real 2023 \$ per ton of lithium carbonate equivalent (LCE)



¹Inclusive of sustaining capital costs, freight.
²Europe inclusive of UK.
³Level of integration across mining and refinement players within each country (based off number of integrated players).
 Source: McKinsey Center for Future Mobility; McKinsey MetalSpans

Source: McKinsey & Company: Australia’s Potential in the Lithium Market

The second critical competitive advantage of Australia’s supply is the ability to leverage Australia’s world-leading, low-cost renewable energy to embody decarbonisation into our export market. McKinsey models that by 2030, raw materials will represent 25-40% of the Scope 3 emissions for battery and EV manufacturers. Australia’s integrated mine-to-refinery industry can significantly reduce supply chain emission profiles for EV and battery producers, via the elimination of international shipments of waste rock to further export markets i.e. North America and Europe. Australian refiners can utilise Power Purchase Agreements (PPAs)

from the significant renewable energy capacity expansions across WA's SWIS to significantly mitigate electricity demand Scope 2 emissions in Kwinana and Kemerton.

Australia has the massive potential to power its lithium refineries with zero emissions renewable energy, allowing the export of embodied decarbonisation, to help South Korea deliver on its own decarbonisation objectives.

Further, Australia's landscape allows for mining operations to utilize Virtual Power Plants (VPPs), distributed networks of large-scale solar and wind generation, coupled with Battery Energy Storage Systems (BESS), to eliminate emissions from imported diesel to power daily operations. McKinsey highlights Australia's abundant renewable energy resources to utilise green hydrogen for roasting processes, given the ability to co-locate generation at hydroxide facilities. The ability to decarbonise Australia's critical mineral exports also provides a pathway for jurisdictions across the Indo-Pacific, that lack the geographical resources for large-scale wind and solar, to substantially reduce Scope 3 emissions, enhancing the ESG credibility of their domestic industries.

Indonesia

Indonesia is the world's largest nickel producer. In 2020, Indonesia's President, Joko Widodo, announced the decision to ban export of unprocessed commodities to promote downstream investment and spur economic development. So far, the export restriction has had a material impact on its trade balance. Since 2014, nickel exports have risen over 27-fold to over US\$31bn annually in 2022.¹⁶³

January 2023 saw the FTA between Indonesia and South Korea take effect. The Korea-Indonesia Comprehensive Economic Partnership Agreement (CEPCA) eliminates trade tariffs on 95.5% of Indonesian exports to South Korea, and 93% of Korean exports to Indonesia.¹⁶⁴ The CEPCA eliminated tariffs (previously 5-15%) on South Korean exports of steel products, an important milestone as global automakers are rapidly investing into EV assembly plants in Indonesia.

On 28 March 2023, **POSCO Holdings** established a MoA with China's Ningbo Richin Industry & Trade Co., to establish a nickel value chain across Indonesia, New Caledonia and Australia. Ningbo Richin has a nickel supply chain in Indonesia, from nickel mining to smelting, operating Indonesia's first hydrometallurgy nickel plant for rechargeable batteries since 2021. The new partnership will construct a value-add MHP (mixed hydroxide precipitate) plant, capable of producing 120ktpa in Sulawesi, Indonesia. Phase 1 (capacity of 60ktpa) will begin construction in 2023, with production estimated to commence by 2025.¹⁶⁵

In November 2022, EcoPro BM announced a partnership with Korea's SK On and China's GEM, to construct a MHP plant within the Morowali Industrial Complex in Sulawesi.¹⁶⁶ The plant will produce 30ktpa of pure nickel contained in MHP, with production starting 3Q2024.¹⁶⁷ The plant will offtake nickel from Nickel Industries' Hengjaya mine in Sulawesi, Indonesia. Product

¹⁶³ Nikkei, [Jokowi Squeezes Key EV Material Exports to Spur Indonesian Industry](#), 23 April 2023

¹⁶⁴ ASEAN Briefing, [Indonesia-South Korea Free Trade Agreement to Take Effect](#), 13 December 2023

¹⁶⁵ POSCO, [POSCO Takes First Step in Nickel Business for Secondary Batteries in Indonesia](#), 28 March 2023

¹⁶⁶ EcoPro, [Established a Joint Venture Between EcoPro, SK On, and China GEM](#), 25 November 2022

¹⁶⁷ KED Global, [SK On, EcoPro, China's GEM to Build Battery Materials Plant in Indonesia](#), 25 November 2022

from the MHP plant will be exported to the partnership's new pCAM facility in Saemangeum, Korea (discussed in previous sections).¹⁶⁸

In 2022, Australia matched Indonesia in nickel reserves as the global leader, containing 21Mt of nickel. However, by a significant margin, Indonesia is the world's largest nickel miner globally, producing 1.6Mt in 2022, followed by the Philippines (330kt) and Russia (220kt). In 2022, Australia mined 160kt of nickel, making it the 5th largest globally according to the US Geological Survey.¹⁶⁹

Indonesia is diversifying its industry, producing refined products from hydrometallurgical and pyrometallurgical processes. Nickel laterite ore consists of upper limonite and bottom layer saprolite, characterised by different nickel and cobalt grades. Saprolite is processed using pyrometallurgical processes to produce **nickel pig iron (NPI)** or ferronickel. Pyrometallurgy is a highly energy intensive, highly carbon intensive and low recovery process, with the cobalt embedded containing no value. Most NPI operations utilise coal-fired electricity generation, with refiners often relying on imported ore. The global nickel export market is almost exclusively saprolite.¹⁷⁰

Limonite is processed using **High Pressure Acid Leaching (HPAL)**, a capital-intensive process with significant environmental footprint that requires large tailings dams and effluent treatment. Indonesia has outlawed the use of deep-sea tailings disposal (DSTP), requiring projects to construct land-based tailings that have significantly added to the capital intensity of HPAL in Indonesia.¹⁷¹ Although tailings are not disposed of into the ocean, the effluent generated often leaks into the ocean given poor waste management.

According to Benchmark Minerals' Nickel ESG Report, only a quarter of nickel refineries operating in Indonesia have water pollution monitoring systems in place, lagging significantly behind the global standard.¹⁷² Untreated tailings can pollute water systems, leading to highly deleterious effects for marine biodiversity. Exhaust from the high use of coal plants within nickel smelting facilities also causes water temperatures to rise, driving away local marine populations critical to Indonesian communities.

Queensland Pacific Metals' TECH facility will use a patented recovery and recycling process, *DNi Process*, eliminating tailings dam requirements, producing minimal waste and using over 98% recycled nitric acid (higher yield and lower acid use than HPAL) in its operations. The DNi process also uses iron and aluminium hydrolysis to precipitate high-grade hematite, which is then filtered, agglomerated and pelletized for sale to steel manufacturers.

Compared to HPAL, QPM's DNi process is able to extract all valuable metals from laterite ore and recycle all process liquids, a major advantage to HPAL which disposes of effluent into the ocean or evaporates from tailings impoundment. Further, the DNi process leeches almost all ore feed, with residue amounting to ~ 0.25 tonne residue / tonne of ore and is inert. HPAL has a residue footprint of 1.2-1.4 tonne residue / tonne of ore, leading to expensive and large tailings dams, filtration and dry stacking. The inert waste from DNi can potentially be used as

¹⁶⁸ EcoPro, [Establish JV Between EcoPro, SK On and GEM for Precursor Production](#), 28 March 2023

¹⁶⁹ USGS, [Mineral Commodity Summaries 2023](#), 31 January 2023

¹⁷⁰ QPM, [Feasibility Study Confirms TECH Project Credentials](#), 28 November 2022

¹⁷¹ Wood Mackenzie, [The Rise and Rise of Indonesian HPAL - Can it Continue?](#), 4 April 2023

¹⁷² Benchmark, [Nickel Refiners in Indonesia Lag Global Peers on Water Pollution Monitoring](#), 22 March 2023

engineering fill leading to zero solids waste.¹⁷³ QPM is a perfect example of Australian value-added projects that exceed global ESG standards and has catalysed FDI and collaboration between export credit agencies with strategic markets that leverage the US IRA and free trade agreements in place.

¹⁷³ QPM, [The Future of Nickel Laterite Processing - DNi Process](#)

Section 6. Implications for Australia

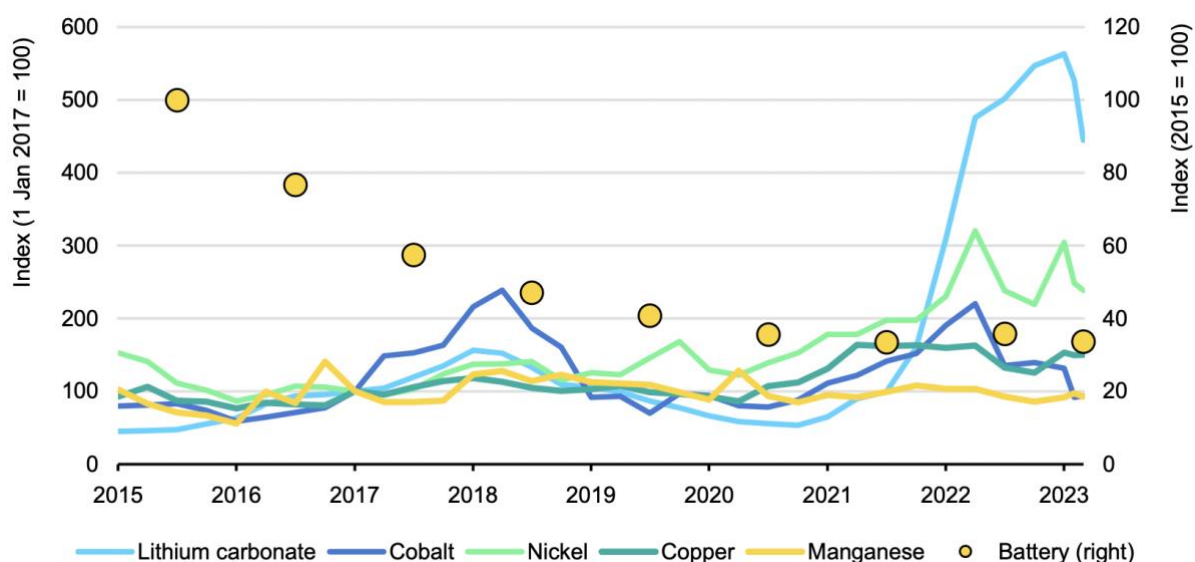
South Korea and Australia need to construct a joint policy response to the ~US\$800bn stimulus of the US Inflation Reduction Act and Europe’s Net Zero Industry Act, a bilateral agreement that best accelerates collaboration and joint investment endeavours to deploy capital in high value manufacturing initiatives, with a key focus on battery supply chains. There is also a massive opportunity to deploy the latest available technologies in clean energy generation to export embodied decarbonisation.

The continued growth of lithium-ion batteries in electrified transport is a critical driver for Australia’s new energy mineral and metal industry. Secondary batteries account for 80% of global lithium consumption, with Australia supplying over 53% of total raw mineral supply in 2022.¹⁷⁴ Australia’s lithium exports are forecast to more than triple from 2021-22, to over \$18.6bn in 2022-23 according to the Office of the Chief Economist.

The global lithium supply deficit to the blistering demand growth of electrified transport translated to unprecedented earnings for Australia’s lithium miners. This has translated to material investment into WA’s economy, with billions of new capital flowing into capacity expansion and downstream integration to value-added lithium products. However, for Australia to realise and maximise our long-term economic benefit from our abundant new energy mineral resources, we cannot rely on significant mineral price hyperinflation to bolster our export value as the world transitions to a green economy.

Since 2015, lithium-ion battery packs have deflated more than 60% into 2023, driving dramatically improved economics of new energy vehicles. As new EV battery manufacturing capacity, and more importantly, midstream refining and processing capacity is established, raw mineral and feedstock prices will stabilise as the electrified transport supply chain’s limiting factor de-bottlenecks.

Figure: Price of Selected Battery Materials and Lithium-ion Batteries 2015 to 2023



Source: IEA Global EV Outlook 2023

¹⁷⁴ OCE, [Resources and Energy Quarterly March 2023](#), 3 April 2023

In order to safeguard and expand Australia's export revenue as the world transitions to a decarbonised economy, it is Australia's national interest to scale and support value-adding mineral and metal projects onshore, integrating cleantech manufacturing and positioning Australia as a globally competitive supplier. Australia's productivity has stagnated, there is a physical limitation to increasing extraction efficiency given declining grades. We must do more to onshore higher-value products, not just focus on reducing costs.

Global economies are rapidly seeking to reform critical supply chains to bolster energy and resource security and diversify from jurisdictions that have concentrated manufacturing. Jurisdictions that identify key future facing markets decades in advance need to funnel public and private capital into unlocking these new export industries. Failure to previously identify the significant growth and value of downstream processing and manufacture left Australia as a quarry to the world. A second chance has presented itself to Australia as nations seek to re-industrialise, onshoring cleantech downstream and midstream industries to decarbonise whilst supporting new job creation and spurring economic growth. If Australia fails to act at the necessary speed and scale necessary to diversify value-added critical mineral supply chains to emerging markets, Australia will again be locked out of the true value market by fast moving economies.

Speaking at an Australian-Korean Business Council (AKBC) forum in November 2022, POSCO Australia's Director, Ben Kim, expressed the vital importance of Australia's critical mineral industry for POSCO's integrated battery manufacturing strategy. If Australia wants to build downstream processing plants, it needs to establish manufacturing facilities with active participation from the Government to facilitate investment. Australia must improve its regulatory environment and foreign investment stance to enable an inflow of overseas capital from investors in a collaborative new way.¹⁷⁵

Climate Energy Finance sees it as imperative that the Australian government initiate bilateral trade discussions with South Korea that accurately reflects the modern global landscape. CEF urges South Korea and Australia to construct a joint policy response to the ~US\$800bn stimulus of the Inflation Reduction Act and Europe's Net Zero Industry Act, a bilateral agreement that best accelerates joint investment endeavours' to deploy capital in high value manufacturing initiatives, build critical mineral supply chains and deploy the latest available technologies in clean energy generation and embodied decarbonisation.

Expanding Australian-Korean critical mineral cooperation presents an enormous value-added trade opportunity, taking mutual advantage of the lead South Korea has established as a globally competitive battery materials manufacturing jurisdiction with world-class expertise/ Australia has a strong history of working constructively with Korea. Australia provides a new supply network and export market for South Korea, one that compliments Korea's strategic focus on the rapidly expanding North American battery market and maximises financial incentives and support given both economies FTA's across North America. Establishing mutually-beneficial upstream and midstream capacity on both nations' shores safeguards Australia's and South Korea's job creation and domestic GDP growth from the new energy transition.

¹⁷⁵ HotCopper, [South Korea Steel Giant POSCO Eyes off WA Critical Minerals Sector Through Pilbara Minerals Venture](#), 30 November 2022

Australia is gaining momentum in value-adding onshore. In March 2023, Climate Energy Finance's published its flagship critical minerals report, '[A Critical Minerals Value-Adding Superpower](#)', highlighting the capital flows into value-added projects onshore across critical minerals and metals including lithium, rare earths, nickel, copper, vanadium and manganese, the importance of Australia's EFA, NAIF, CEFC, ARENA and the Future Fund, and the integration of renewable energy will establish Australia as a globally competitive value-added market. Since publication, multiple projects have been announced in Australia's value-added investment pipeline.

In June 2023, Australian lithium giant, Pilbara Minerals, began the search for a joint venture partner to construct a \$1bn lithium processing plant. Pilbara Minerals have partnered with POSCO for the development of the US\$800m LHM facility in Gwangyang, South Korea.¹⁷⁶ The new proposal however, is seeking for a 50:50 partnership, with Pilbara Minerals positioned far stronger now than it did in previous years. Critically, Pilbara Minerals choice of location would be driven heavily by government subsidies, naming specifically the effect of the US IRA as a pulling mechanism to the states.

In May 2023, US lithium giant **Albemarle**, announced a US\$1.25bn expansion of its Australian LHM facility in Kemerton, WA.¹⁷⁷ The investment would double capacity of the refinery to 100ktpa, sufficient to support the production of 2.4 million EVs annually. The Kemerton plant was originally constructed as a joint venture between Albemarle and ASX Mineral Resources. However, Mineral Resources stake in Trains I and II were diluted to 15% as part of a corporate structure to regain a greater share in its Wodgina and equity in two of Albemarle's lithium refineries in China. The new expansion, Trains III and IV, are wholly-owned by Albemarle.

Albemarle is the largest lithium firm in the United States. Signed in May 2023, the Australian-US Climate, Critical Minerals and Clean Energy Transformation Compact has significantly enhanced the mineral trade partnership between the two nations. The US is working closely with key private firms to secure new supply for domestic manufacturers in the US scaling midstream and downstream capacity. The 50ktpa expansion of Albemarle Kemerton is equivalent to the entire capacity of its two competitors' new LHM plants in WA, IGO-Tianqi Kwinana (48ktpa) and Wesfarmers-SQMs Kwinana (50ktpa).

McKinsey's aforementioned report (Section 5) highlighted that decisions made by global lithium sectors in 2023, will determine how the global industry will look in the 2030s. Australia's lithium sector can become the world's lowest-cost hydroxide supplier due to its integrated mineral-to-refinery model, and leveraging Australia's renewable energy resources to embody decarbonisation to our key trade partners. Creating a mutually-beneficial bilateral agreement between Australia-South Korea, that reflects the pace and scale of the current investment environment is moving, that maximises competitive advantages across mining and manufacturing expertise across both jurisdictions, ensures domestic capability is not locked out of the North American battery market.

In April 2023, ASX IGO Ltd and Wyloo Metals secured land in WA's Kwinana for a proposed **Integrated Battery Material (IBM) Facility** in the Kwinana-Rockingham Strategic Industrial Area, adjacent to IGO's LHM facility joint venture with Tianqi Lithium. The IBM facility would construct an integrated downstream nickel refinery and potentially a high-value nickel-rich

¹⁷⁶ AFR, [Pilbara Minerals Starts Global Hunt for Processing JV; MacCap Mandated](#), 22 June 2023

¹⁷⁷ Albemarle, [Albemarle to Double Lithium Hydroxide Output in Australia](#), 3 May 2023

precursor-CAM plant. The partnership would leverage IGO's vast nickel mining assets across WA and proprietary nickel refining technology to integrate and onshore the nickel, cobalt and manganese value chains prior to cathode production.¹⁷⁸

In its regulatory filing, IGO stated the joint venture was in advanced discussions with a global battery chemical manufacturer with strong interest in the project. If discussions are with a South Korean firm, each industry would benefit greatly from the mutually-beneficial partnership. It provides a pathway to diversify supply chains from China, procuring critical resources for the rapid expansion of domestic cathode production and mitigating significant emissions by eliminating the export of waste ore. If South Korean chemical firms were to partner as a foundational customer, precursor products can be tailored to vertically integrate into Korea's cathode industry requirement, as well as de-risk the project through cooperation of each nations' export credit agencies to accelerate development and catalyse further investment.

The South West Interconnected System (SWIS) is WA's main electricity network, with which the Kwinana-Rockingham Strategic Industrial Area is connected. The growth of WA's processing and manufacturing industries will increase the electrical demand on the SWIS. In May 2023, the WA Government published the SWIS Demand Assessment 2023-2042, which announced the transition to large-scale solar and wind generation coupled with long-duration battery storage (LDES) as part of a 50GW expansion of new renewable energy capacity.¹⁷⁹ On 20 June 2023, French-based Neoen announced a massive 219MW/877MWh four-hour battery in Collie, WA.¹⁸⁰ Tesla will supply 224 of its 2XL Megapacks for the project.

The Demand Assessment revealed large-scale solar and LDES as the most cost-efficient form of firmed renewable generation.¹⁸¹

The battery value chain opportunity should leverage Australia's credentials in world leading mining capacity, but also our critical mineral resource base and Australia's world scale, low-cost renewable energy resources so as to enable onshore processing and refining pre-export. Australia should be exporting embodied decarbonisation in value-added resources, providing globally competitive products that will massively benefit South Korean industry decarbonise its Scope 3 value chain emissions, as key export markets crack down on traceability and ESG standards in cleantech products.

As nations seek to extract a larger share of value from the global technology race, Australia needs to work constructively with South Korea to ensure both economies are not locked out of North American value-added industry and work constructively to leverage our combined world-leading capacity and expertise.

¹⁷⁸ IGO Ltd, [Land Secured at Kwinana for Proposed Integrated Battery Material Facility](#), 14 April 2023

¹⁷⁹ WA Gov, [SWIS Demand Assessment](#), 17 May 2023

¹⁸⁰ Renew, [Neoen and Tesla to Build Giant 4-hr Battery in Landmark Deal to Squash Solar Duck](#), 20 June 2023

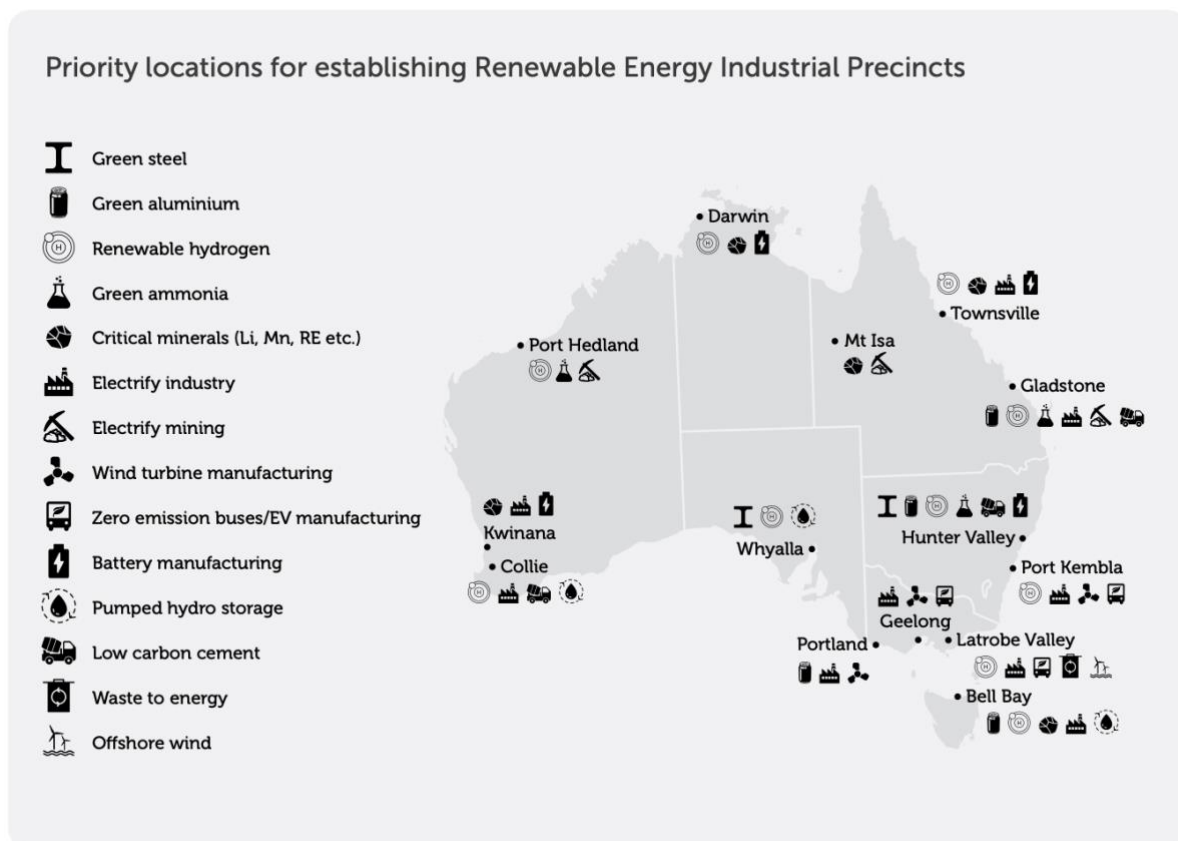
¹⁸¹ Renew Economy, [WA Plans Huge Switch to Solar and Storage with Stunning 50GW Green Energy Boom](#), 10 May 2023

Section 6.1. Renewable Energy Industrial Precincts

Climate Energy Finance sees domestic Renewable Energy Industrial Precincts (REIPs) as a key mechanism to establish globally competitive export hubs that also foster an environment for international partnerships to co-invest in domestic manufacturing capacity. REIPs provide a pathway to utilise Australia’s economic strengths in mining, mineral processing and value-added manufacturing, unlocking regional hubs with integrated supply chains and direct access to ports to supply global markets at competitive prices, driven by synergies across new energy value chains and decarbonised energy supply.

Beyond Zero Emissions (BZE), an independent Australian think tank, identified 14 priority locations across Australia to establish dedicated clusters for new industry manufacturing, powered by 100% renewable energy. Channelling public-private capital, both domestic and foreign, into regional communities unlocks significant domestic job markets and economic growth to bolster Australia’s exports.¹⁸²

Figure: BZE Renewable Energy Industrial Precincts across Australia:



Source: Beyond Zero Emissions ¹⁸³

The South Korean battery value chain is a key example of utilising common infrastructure to scale capacity across chemical processing and material manufacturing, minimising transport, freight costs and leveraging in-house capacity to produce globally competitive battery exports. POSCO Future M’s hubs across Gwangyang and Pohang are key examples of localising production, allowing firms to minimise capital outlays through shared infrastructure and reduced production costs through integrated supply. EcoPro’s Pohang campus is a fully-

¹⁸² BZE, [Renewable Energy Industrial Precincts – Economic Analysis Summary Report](#), July 2021

¹⁸³ BZE, [Renewable Energy Industrial Precincts – Economic Analysis Summary Report](#), July 2021

integrated battery ecosystem for producing high-nickel content cathodes, sourcing materials from within the same industrial complex.

Taiwan's foreign minister, Joseph Wu, said for Australia to maximise its critical minerals potential, it would have to develop an ecosystem similar to Taiwan's Hsinchu Science Park, where both upstream and downstream manufacturing is managed together. The industrial complex is home to Taiwan Semiconductor Manufacturing Co., responsible for more than 90% of the world's most advanced chips and over 50% of the world's semiconductors.¹⁸⁴

Taiwan's semiconductor industry was not built overnight, it was the product of 40 years of strategic investment and long-term vision, steadily localising all areas of production. If Australia is to become a global value-added critical minerals and rare earths producer, it must foster a climate for international partnerships onshore, supporting independent technologies through allocation of resources that creates an environment for long-term integrated supply.

Korea's Ministry of Trade, Industry and Energy (MOTIE) announced its plan to diversify and expand Korea's scope of batteries and materials. Specifically, investing into R&D for sodium-ion, redox flow and LFP batteries, all of which are used primarily in stationary storage. South Korean firms have neglected LFP chemistries, opting for higher-nickel alternatives for the EV industry. China dominates lithium-ion cell manufacturing for battery storage.

Korean firms cannot produce iron batteries within the same facilities as nickel batteries, which use magnet sweepers to remove any trace of iron in the manufacturing process, requiring Korean companies to establish separate plants and specialised midstream supply, according to SNE Research.¹⁸⁵ The success of Korea's LFP future is whether firms will have the cost competitiveness of Chinese rivals in stationary storage supply.

Climate Energy Finance recommends the Australian Government allocates resources to establishing REIPs that provide a pathway for streamlined international co-investment into developing an integrated downstream industry of chemical processing and cell manufacturing for the domestic stationary storage industry. Dedicating public, patient capital into enhancing REIPs creates a long-term market signal for established cell and material manufacturers to direct growth capex into an Australian downstream industry.

¹⁸⁴ AFR, [Australia's Critical Mineral Push Will Make World Safer: Taiwan](#), 20 June 2023

¹⁸⁵ Bloomberg, [Korea's Battery Makers Embrace LFP Cells as China Strides Ahead](#), 15 May 2023

Section 6.2. Opportunity in India

Like the massive opportunities for greater Australia-Korea collaboration in mining through to battery and EV manufacturing, Australia also needs to think more strategically about the importance of greater Australia-India opportunities. India's economy is undergoing sustained strong economic growth, and there is clear strategic opportunity for far greater Australia-India trade, investment and alignment, particularly with the growing climate-energy-defence alignments of the US-Japan-India-Australia QUAD alliance.

India is the world's sixth-largest economy with a GDP of \$4.3 trillion and a population of 1.4 billion, now the largest in the world. Despite its size, India is one of the fastest growing economies, with OECD upgrading its forecast 2023/24 economic growth for India to 6% in June 2023, repeating the strong growth of the previous two years.¹⁸⁶

Deepening the trade and investment network with India is a key priority for the Australian Government. In March 2023, India and Australia reached a major milestone in expanding trade and joint investment in critical mineral projects. Both nations agreed to strengthen cooperation and enhance the Australia-India Critical Minerals Investment Partnership.

India is making considerable efforts across climate change policy in order to build climate resilience and secure a stable clean energy generation and network distribution. In August 2022, India updated its NDC (Nationally Determined Contribution) to i) source 50% of India's cumulative electric power installed capacity from non-fossil sources, and ii) reduce the emission intensity of GDP by 45% below 2005 levels by 2030.¹⁸⁷ India currently has 67GW of solar and 42.8GW of wind capacity in 2023, with ambition to reach 500GW of non-fossil fuel electricity capacity by 2030.¹⁸⁸

As the world transitions to a net-zero landscape, India is seeking to decarbonise its economy whilst also bringing onshore its own industrial manufacturing supply chains. Renewable energy generation, battery storage manufacturing and electrified transport production provide a pathway for India to expand its booming job market, and facilitate trade with Australia's critical mineral industry, creating an opportunity for Australia to expand our value-added export profile with embodied decarbonisation. ANZ Chairman, Paul O'Sullivan, expressed the urgency for Australian firms to build upon and engage with the opportunity that is presenting itself between our two economies, enhancing the trade links and partnerships to improve the terms and conditions under which Australia operates.¹⁸⁹

In 2019, India approved the second phase of its Faster Adoption and Manufacturing of Electric Vehicles (FAME-II) policy framework. FAME-II included a number of improved policies and incentives for electric adoption, namely the Production Linked Incentive (PLI) scheme for the scaling of domestic manufacturing and cell production onshore.

The PLI created a market signal for original equipment manufacturers (OEMs), both domestically with Tata Motors and Mahindra, and internationally with BYD and Hyundai, so that India will become a hub for EV component manufacturing and reduce import dependency pressures that have inflated EV prices globally. Over half of India's three-wheeler

¹⁸⁶ AFR, [India is now Bigger than China. Why that Matters for Australia](#), 6 April 2023

¹⁸⁷ United Nations, [India's Long-Term Low-Carbon Development Strategy](#), 14 November 2022

¹⁸⁸ AFR, [Energy-hungry India has a Natural Green Ally in Australia](#), 24 March 2023

¹⁸⁹ AFR, ['You Can't Not Be Here': Inside ANZ's India Opportunity](#), 9 June 2023

registrations were electric in 2022. Purchase incentives in FAME-II, supply-side incentives under the PLI scheme, tax benefits and India's Go Electric campaign all contributed to reducing the higher upfront costs of EV deployment.¹⁹⁰

In 2021, the Ministry of Heavy Industries dedicated US\$2.2bn to boost domestic cell manufacturing, through the Production Linked Incentive for Advanced Chemistry Cell (ACC) Battery Storage with the aim of reaching a cumulative 50GWh of new EV manufacturing capacity over 5-years. In March 2022, the Ministry awarded grants to four projects totalling 50GWh: Ola Electric Mobility (20GWh), Hyundai Global Motors Co (20GWh), Reliance New Energy Solar Ltd (5GWh) and Rajesh Exports Ltd (5GWh).¹⁹¹

On 11 May 2023, **Hyundai Motor Co.** signed an MoU with the Government of Tamil Nadu to invest US\$2.45bn in India over the coming decade to establish an EV battery pack assembly plant, capable of producing 178,000 packs annually.¹⁹² Hyundai currently operates a plant in Chennai with an annual production capacity of 770,000 vehicles. In combination with Kia, the Korean auto group was the 2nd largest automaker in the world's third-largest auto market, behind China and the US.

On 2 June 2023, **Tata Group**, India's largest domestic EV manufacturer, announced the investment decision to construct a US\$1.58bn lithium-ion cell manufacturing plant in Sanand, Northern Gujarat.¹⁹³ The facility, which is expected to commence production by 2025, would have an initial capacity of 20GWh, with ability to expand to 40GWh. The Gujarat State Government highlighted that Tata's investment would go a long way to the development of an EV ecosystem across the state and India as a whole. In August 2022, Tata Motors purchased Ford Motor Co.'s Gujarat manufacturing plant for US\$91.5bn, through its EV subsidiary, Tata Passenger Electric Mobility Ltd.¹⁹⁴

On 13 May 2023, Hyundai announced it had signed a term sheet for the potential acquisition of General Motors Talegaon Plant in Maharashtra. Reports suggest the Talegaon, which had an annual capacity of 130,000 vehicles under GM's management, could be reconfigured into Hyundai's first India-dedicated EV manufacturing base.¹⁹⁵

Climate Energy Finance sees huge geopolitical advantages for increased Australia-India collaboration across government, industry, mining and finance to build on Australia's existing strong educational links and growing Indian diaspora here of upwards of 720,000 people. Given growing trade tensions between the US and China, and India's sustained rise to become the fastest growing large economy in the world - the opportunities for Australia to build collaborations west across the Indian Ocean.

This takes on a wider geopolitical perspective given the growing climate-energy-defence alignment emerging from the US-Japan-India-Australia QUAD alliance in this increasingly multi-polar world.¹⁹⁶

¹⁹⁰ IEA, [Global EV Outlook 2023](#), 26 April 2023

¹⁹¹ India Gov, [Allotment for 50GWh of Battery Capacity to 4 Successful Bidders under PLI ACC](#), 24 March 2022

¹⁹² JoongAng Korea, [Hyundai Motor to Invest \\$2.45bn in India for EV Battery Plant](#), 11 May 2023

¹⁹³ Reuters, [India's Tata Group Signs \\$1.6bn EV Battery Plant Deal](#), 3 June 2023

¹⁹⁴ Reuters, [Tata Motors to Buy Ford India's Manufacturing Plant for \\$91m](#), 8 August 2022

¹⁹⁵ KED Global, [Hyundai to Boost India Presence via Takeover of GM Plant](#), 13 March 2023

¹⁹⁶ The Economist, [Joe Biden and Narendra Modi are drawing their countries closer](#), 15 June 2023