Iron and steel's US$ 1.4 trillion shot at decarbonisation

Steel industry's decarbonisation quest and its impact on raw materials

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Wood Mackenzie
A Verisk Business

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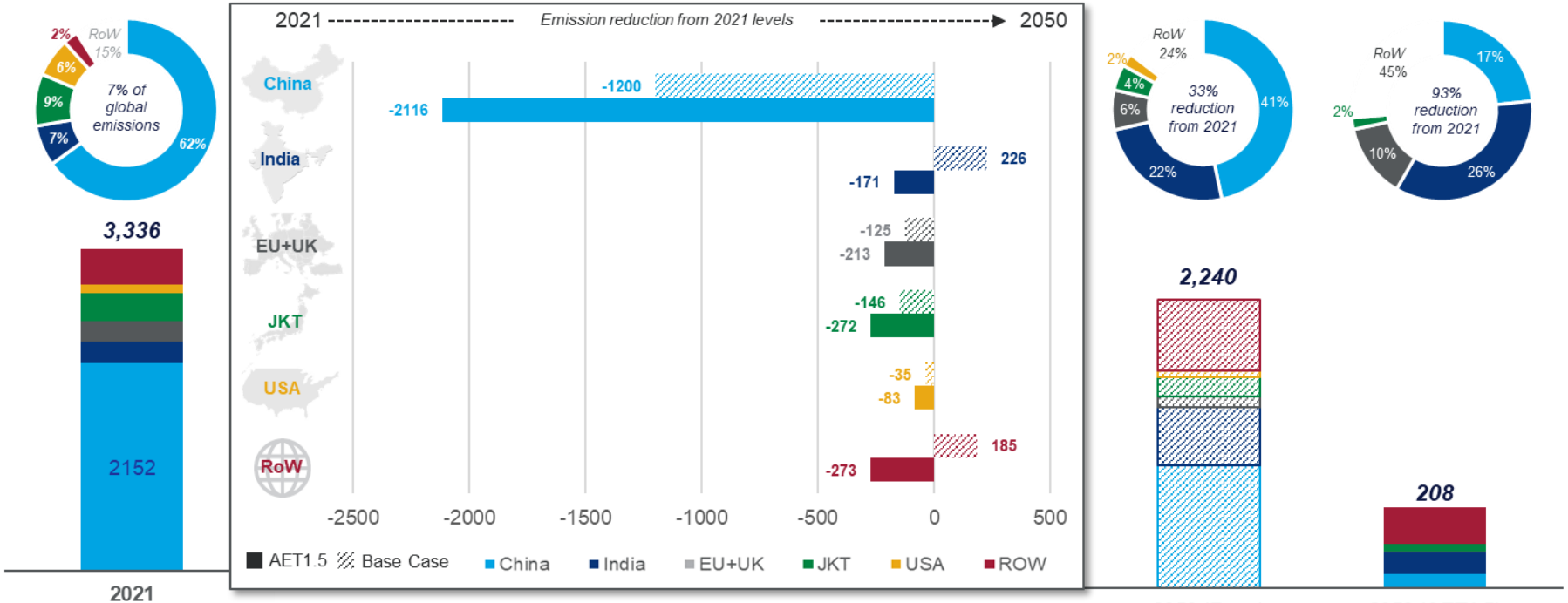
Impact on Raw Materials

Iron and steel's US$ 1.4 trillion shot at decarbonisation

Steel emissions in AET1.5 must decline 93% compared to 2021 to 208Mt

Base case steel emissions to reach 2.2 $BtCO_2e$ by 2050; a-third lower than 2021

Emissions – All numbers in Mt



Under AET1.5 - The onus will be on advanced economies to lead. China, Europe, USA and JKT will pare down more than 95% emissions from current levels by 2050. Developing nations will also have to accelerate efforts to limit emissions. India will need to reduce emissions by 72% even as its steel output grows fastest amongst others.

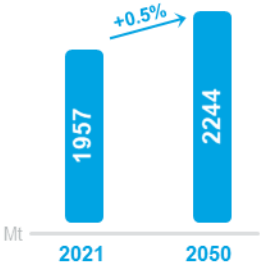
Source: Wood Mackenzie

What changes in AET1.5 compared to base case

Scrap stays rangebound; rise in DRI hurts hot metal; Electrolysis (MOE) is included

Steel Output

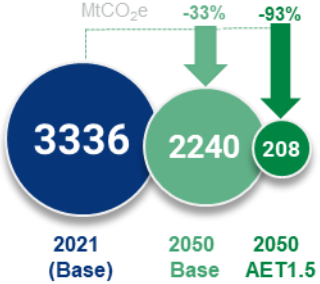
Steel production stays same as base case



Global steel production to grow at an annual rate of 0.5% to reach nearly 2,254Mt by 2050

Emissions

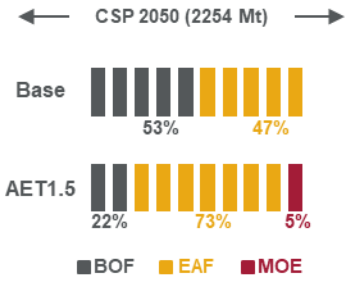
Ambitious emission targets set under AET2 and AET1.5



Decarbonisation efforts must intensify as AET1.5 targets seem far out of reach

Steelmaking route

Molten Oxide Electrolysis - a new steelmaking route for AET1.5



Under AET1.5 - EAF share touches 73%. Molten oxide electrolysis (MOE) finds an inclusion. BOF is increasingly abandoned by steelmakers under pressure to decarbonise

Metallics demand

Metallics undergo a major overhaul

Mt	Scrap	DRI	Hot Metal
Base (2021)	750	117	1369
Base (2050)	1200 (1.6x)	279 (2.4x)	1150 (0.84x)
AET1.5 (2050)	1294 (1.7x)	549 (4.7x)	608 (0.45x)

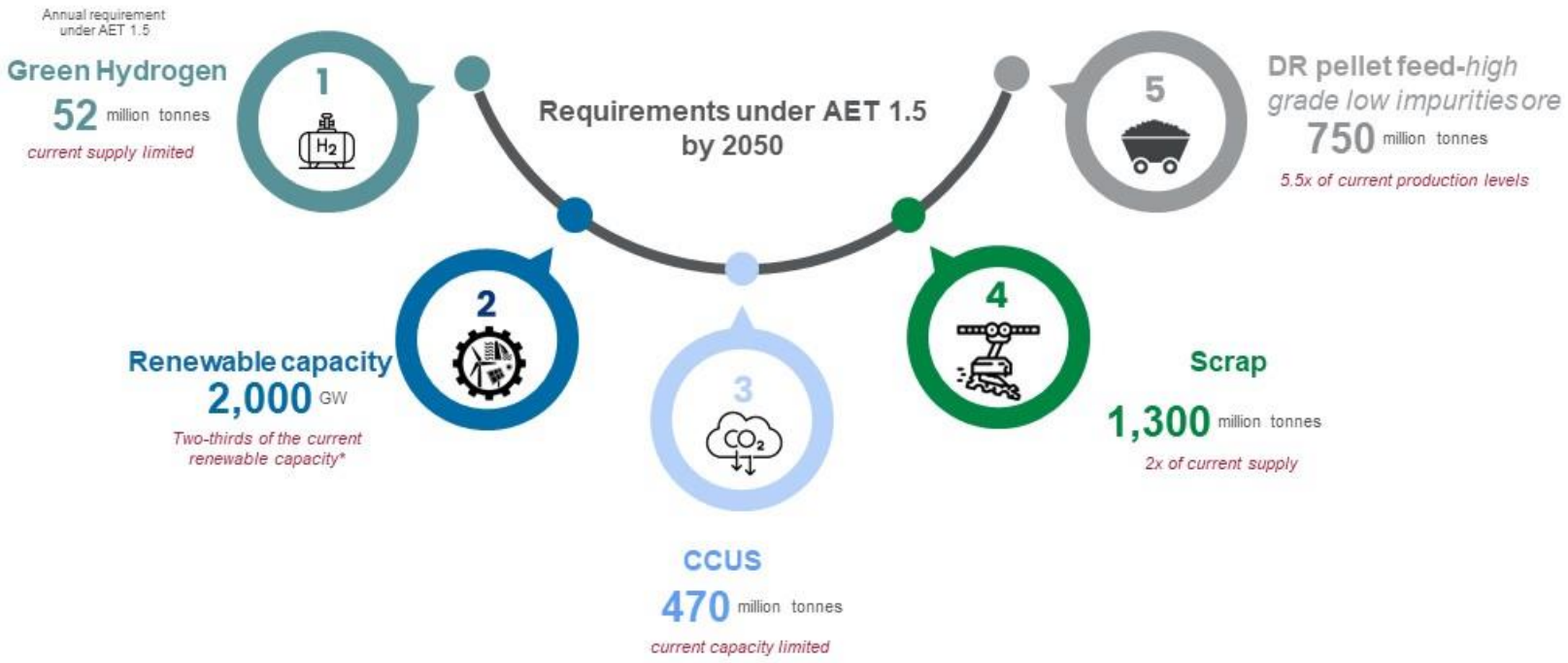
x: change as compared to Base (2020)

Metallics demand will have to evolve under AET1.5 –
Scrap pool needs doubling from current levels
DRI production must rise five-fold to touch 550Mt
Hot metal to halve from current levels

Source: Wood Mackenzie

Decarbonisation for steel and iron ore need multiple enablers

The scale of the challenge is sobering as diverse ecosystem enablers need to be activated to achieve the targets set under AET1.5



* Renewable capacity includes hydro, solar, wind, geo-thermal, bio-energy

Source: Wood Mackenzie

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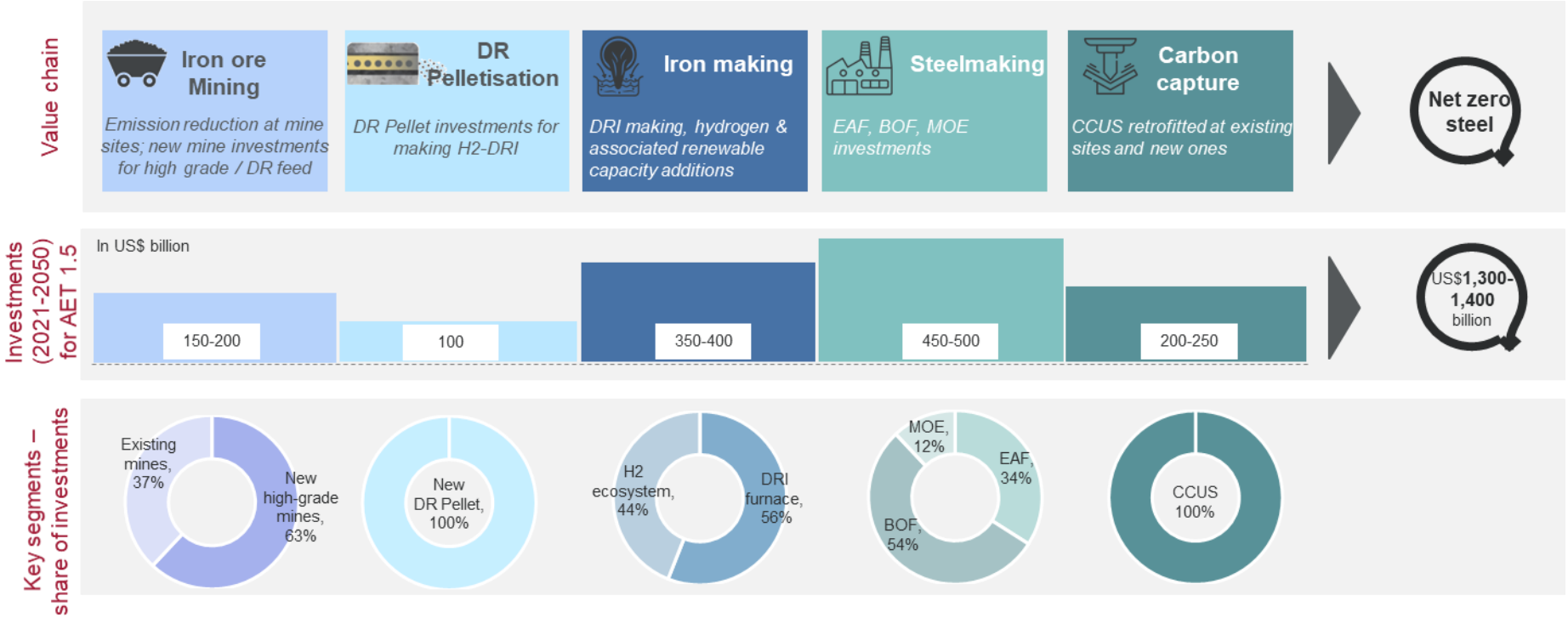
Green Investments

Iron and steel's US$ 1.4 trillion shot at decarbonisation

Greening steel will entail $ 1.3-1.4 trillion investments through 2050

Hydrogen DRI & associated ecosystem along with EAF to see highest spend

Steel and value chain – *Investments needed under AET 1.5 scenario analysis*



Source: Wood Mackenzie

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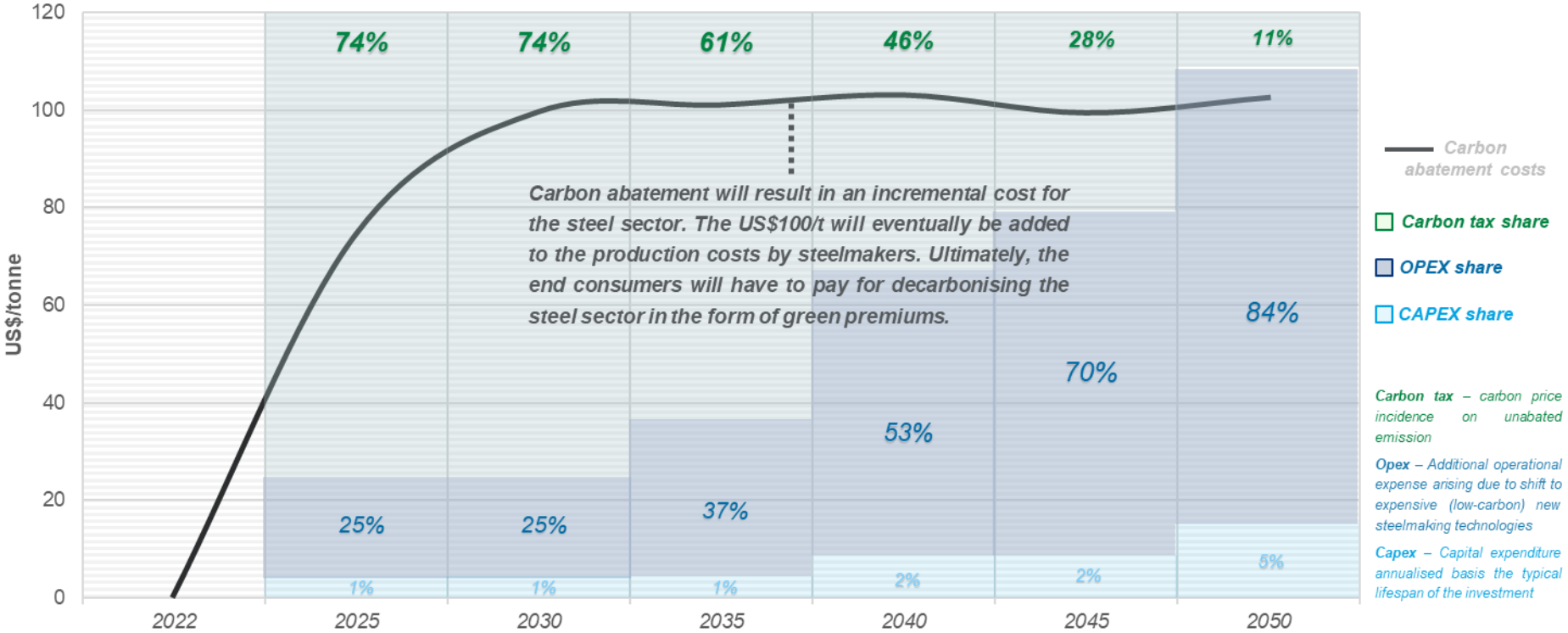
Carbon Abatement Costs

Iron and steel’s US$ 1.4 trillion shot at decarbonisation

Successfully abating carbon by 2050 to cost steelmakers nearly US$100/t

Share of carbon tax is pegged higher upto 2035; OPEX dominates the latter half of the forecast



How to read the chart: The line chart denotes carbon abatement cost for the steel industry. The column chart (in the background) is a bifurcation of the total carbon abatement cost – comprising of CAPEX, OPEX and carbon taxes. For instance, in 2050 the CAPEX share is 5% of US$100/tonne carbon abatement cost which is US$5/tonne

Source: Wood Mackenzie

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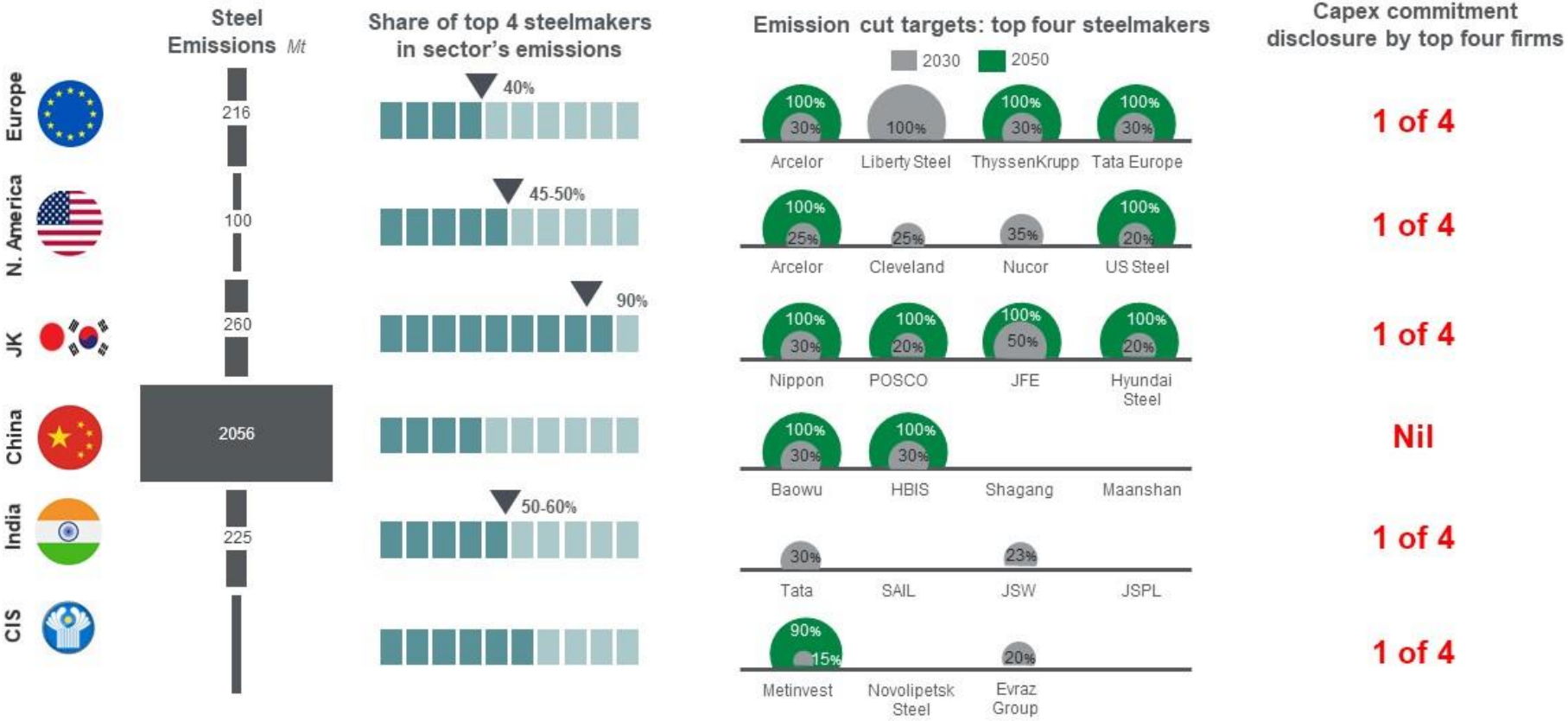
Corporate Net-zero Targets

Iron and steel’s US$ 1.4 trillion shot at decarbonisation

Corporates quick to react to climate change goals

13 of top 25 steel firms set net zero goals but with limited committed capex disclosure

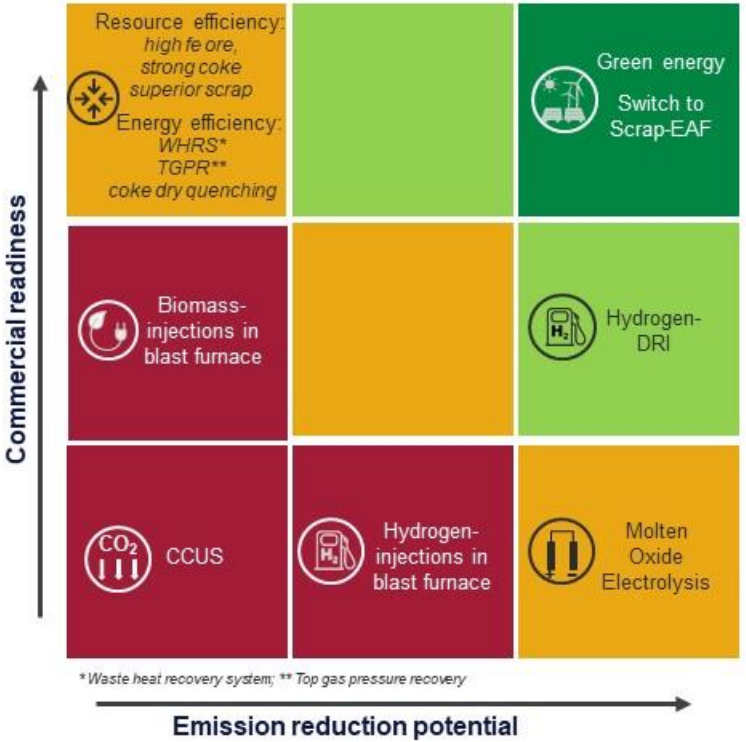


Source: Company Climate Change reports, Wood Mackenzie

Lowering emission intensity must be the top priority of steelmakers

Green energy and Scrap-EAF best bet in near term; H-DRI, electrolysis and CCUS - long term uncertainties

Strategy for steelmakers to decarbonise



* Waste heat recovery system; ** Top gas pressure recovery

	Strategy	Details	Capex Intensity
1.	Operational efficiency	*Implementing resource and energy efficiency measures can help abate 7-8% emissions*	
2.	Green energy & Scrap-EAF	*Renewable energy is unquestionably the way forward; Scrap-EAF, least carbon intensive route, is a natural alternate for steelmakers*	
3.	Hydrogen-DRI & MOE	*New technologies can become a near-zero emission route; commercial viability – a concern*	
4.	New blast furnace technology	*Biomass/hydrogen injections in BF can reduce emission intensity by 15-25%. Currently in testing stages*	
5.	Carbon offset (CCUs)	*Carbon offset measures like CCUS for unabated emissions will be imperative to meet AET targets*	

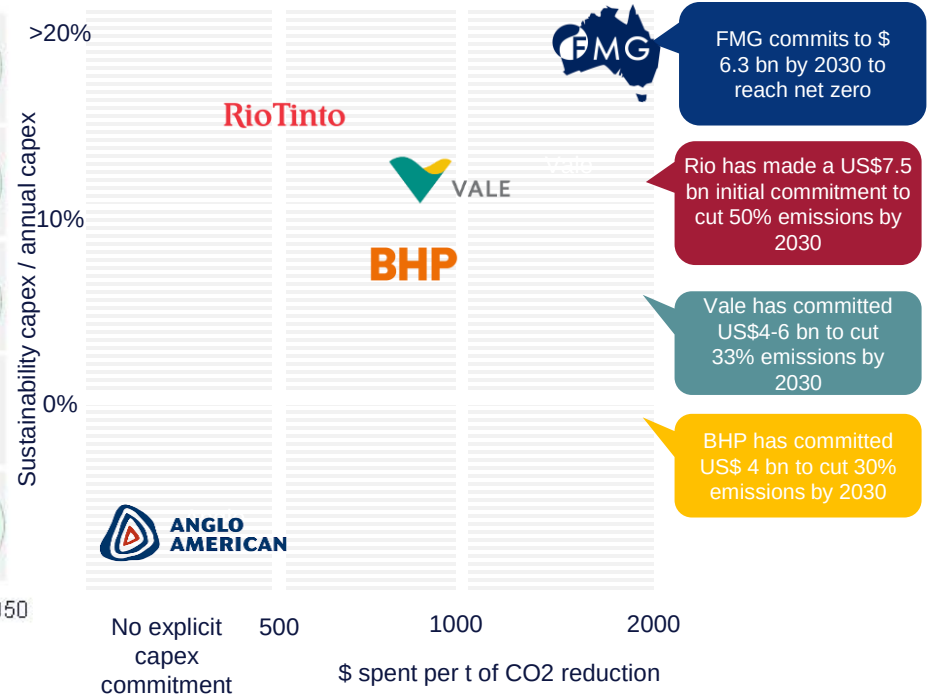
Source: Wood Mackenzie

Majors set intermediate and net zero targets for operational emissions

Allocate around 10% of their annual capital budgets towards creating zero carbon mines

Top 5 miners set emission cut targets

Top four miners allocate US$23-24 bn for 30% emission cuts through 2030 (across business)



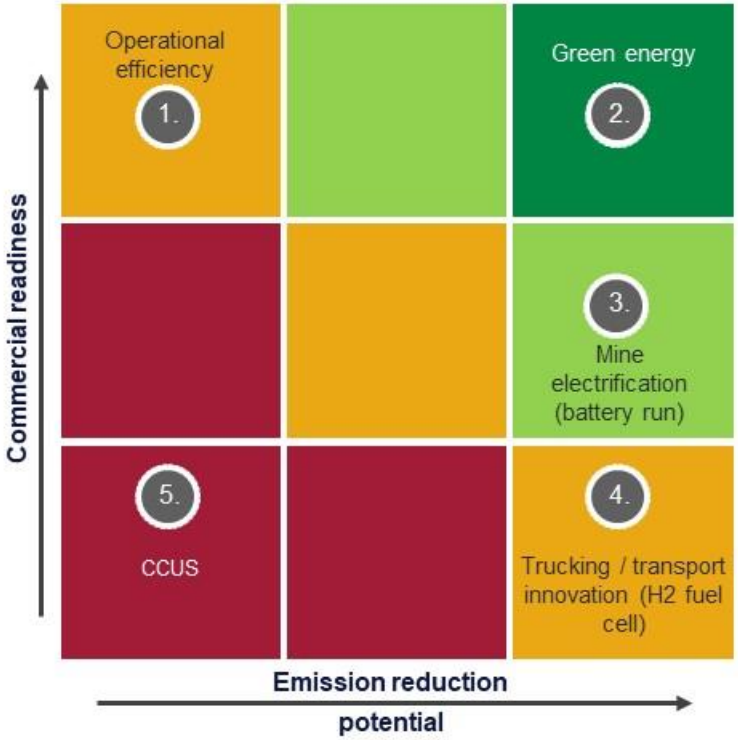
Note: Aforementioned analysis for scope 1 and 2 only; mining emissions include all business units (iron ore, coal, aluminium, etc.). FMG and Anglo have not explicitly announced any capex for the targets set by them in their climate change reports.

Source: Company Climate Change reports, Wood Mackenzie

No silver bullet for miners to decarbonise their emissions

Green energy and efficiency at mine sites will be key carbon abatement tools in medium term

Strategic measures for miners to decarbonise



	Strategy	Details	Capex Intensity
1.	Operational efficiency	*Blending bio-fuels, process improvements, technology improvements, recycling materials*	
2.	Green energy	*Investments in renewable electricity and battery storage; signing PPAs with solar/wind farms*	
3.	Mine electrification	*Electrification of mining fleet to reduce emissions and enhance safety*	
4.	Trucking innovation (H2 fuel cell)	*Hydrogen fuel cell run haulage trucks*	
5.	Carbon offset (CCUs)	*Carbon offset measures like CCUS for unabated emissions (but will come with the risk of "greenwashing" label*	

Source: Wood Mackenzie

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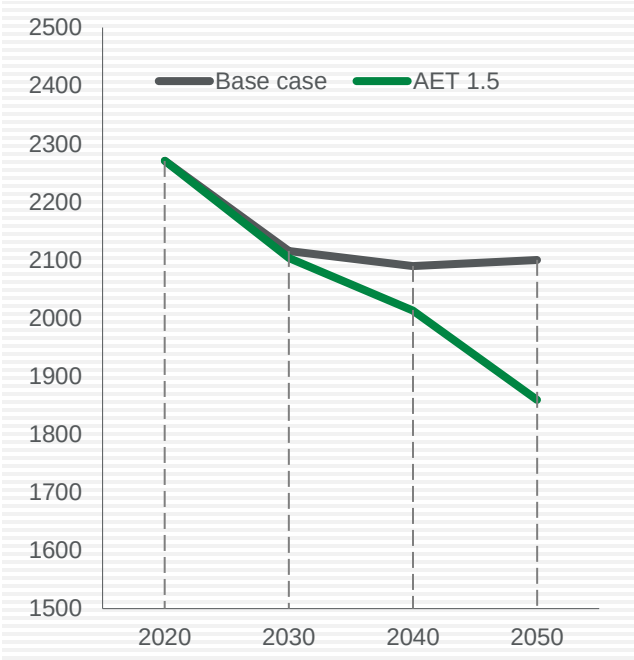
Impact on Raw Materials – Iron ore

Iron and steel's US$ 1.4 trillion shot at decarbonisation

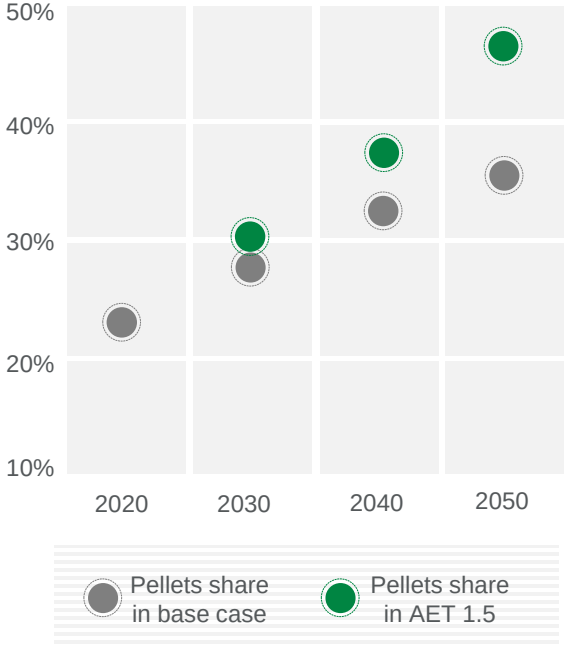
Iron ore demand to decline; pellet market to gain traction

Scrap displacement higher in AET 1.5 hurting iron ore demand more over base case

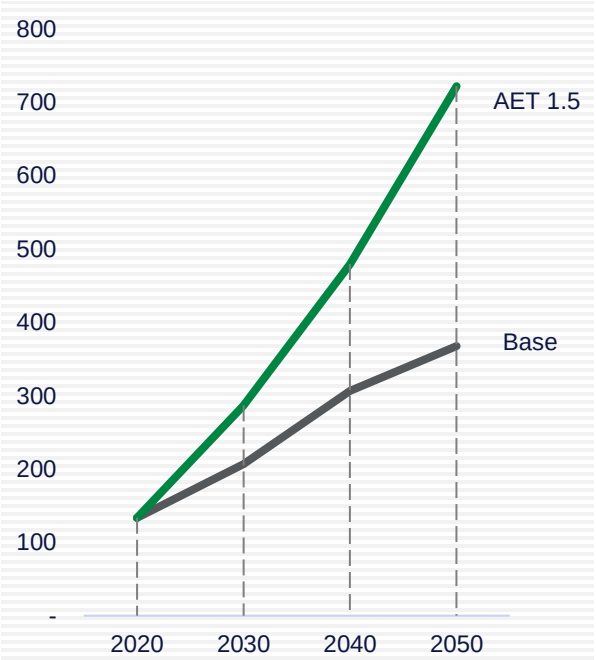
Iron ore demand (million tonnes)



Iron ore product mix



DR Pellet demand (million tonnes)



Global iron ore consumption is around 240 Mt lower than our base case forecast by 2050 led by scrap displacement which picks pace from mid 2030s.

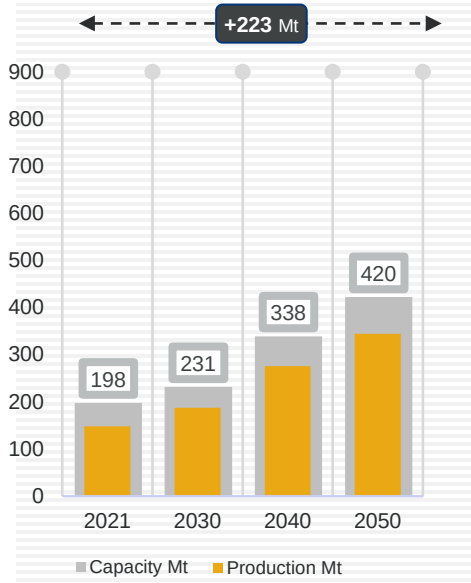
- DRI will benefit the most during steel's decarbonisation pathway
- Commercial adoption of hydrogen based DRI route which will account for a third of total production by 2050
- This shall augur well for DR pellet and pellet feed market which will rise by 5.4x in AET 1.5 (over 2021)

Source: Wood Mackenzie

4.2x of current DR pellet capacity needed to feed green steel under AET 1.5

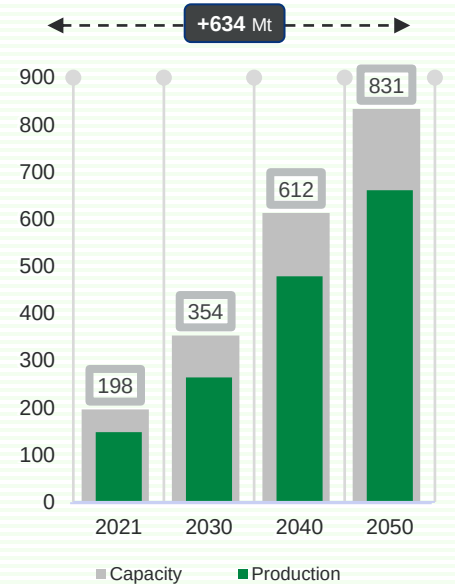
World will need 630 Mt of new DR pellet capacity under AET 1.5

DR pellet supply – *Base case*



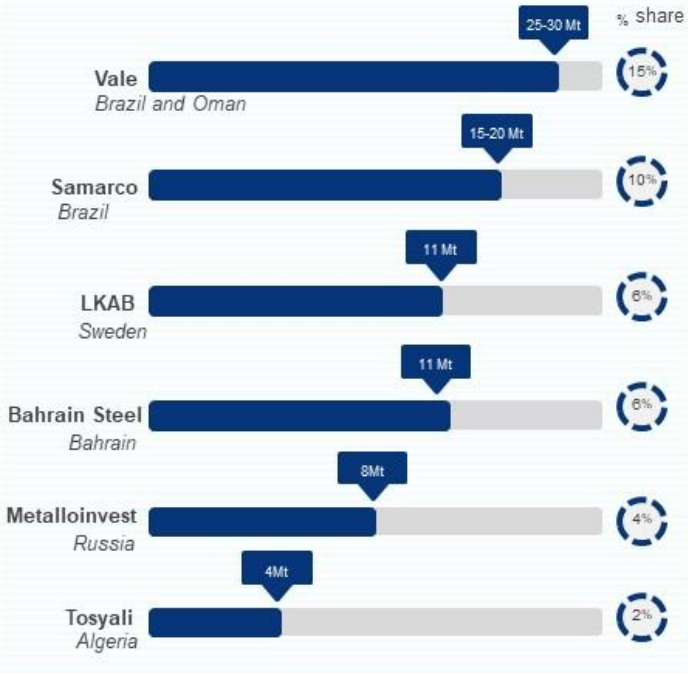
223 Mt of incremental DR pellet capacities will be added in our base case scenario

DR pellet supply – *AET 1.5*



AET 1.5 will warrant nearly 634 Mt of new capacity additions over the next three decades (i.e 4.2x of current capacity base)

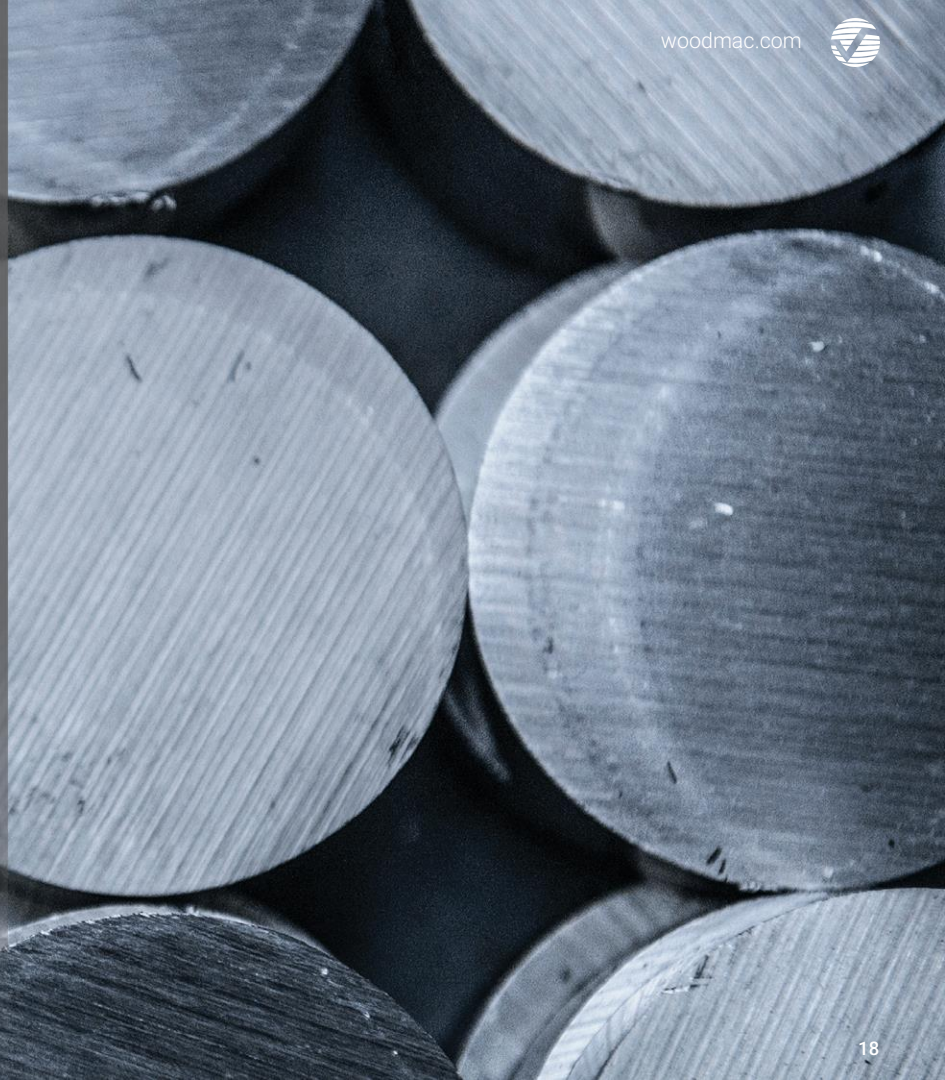
DR pellet current supply landscape – *key players*



Source: Wood Mackenzie, Company reports

Key takeaways

- Geopolitical fragmentation and global stagflation risks to impact markets in near term; to upend decarbonisation drive in long term
- No silver bullet for steelmakers to decarbonise – alternate raw materials (H_2, scrap) and carbon management / CCUs to play critical role
- Green pathway to cost $100/t for steel
- Investments in high grade ore pivotal to feed green steel as its demand quintuples by 2050
- Miners to invest (high grade mines), divest (existing inefficient mines), and forward integrate (DRI/HBI)
- Greenwashing and external support - Collective action needed from corporates, government, policy institutions, and citizens



Malan Wu

Head of Steel & Raw Materials Market, Wood Mackenzie

Biography

Malan joined Wood Mackenzie in August 2020 and is based in Singapore. She heads the Steel and Raw Materials Market team.

Malan has rich experience in commodity analysis, business transformation, and leading teams through cultural change. Before this role, She led a successful career at Rio Tinto across several product groups and geographic locations, driving management and operational excellence with a data-driven and analytical approach.

Most importantly, Malan is passionate about being a transformative leader who walks the talks and brings the best out of the people around Her. Malan enjoys bringing people together to do good work, grow, and have fun!

Malan holds a MSc (Mineral Economics) and Graduate Certificate (Energy) from Curtin Graduate School of Business Western Australia and a Bcom (Economics and Finance) from Curtin University of Technology, Western Australia.

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