WaveStone ESG Report
Quarter ending March 2022

ESG Sector Spotlight – Decarbonising the Pilbara

Listed Australian iron ore producers BHP Ltd (BHP), Rio Tinto (RIO) and Fortescue (FMG) represent some 85% of Australia's annual iron ore production of 920Mtpa. In aggregate the three producers generate 6.1Mpta C02e scope 1&2 emissions and 871.4Mtpa C02e of scope 3. This compares to total industry iron ore production of 2.4Btpa, scope 1&2 emissions of 70Mtpa and 2.7Bt C02e of scope 3 emissions (*source: 2021 Annual reports for BHP, FMG and RIO*).

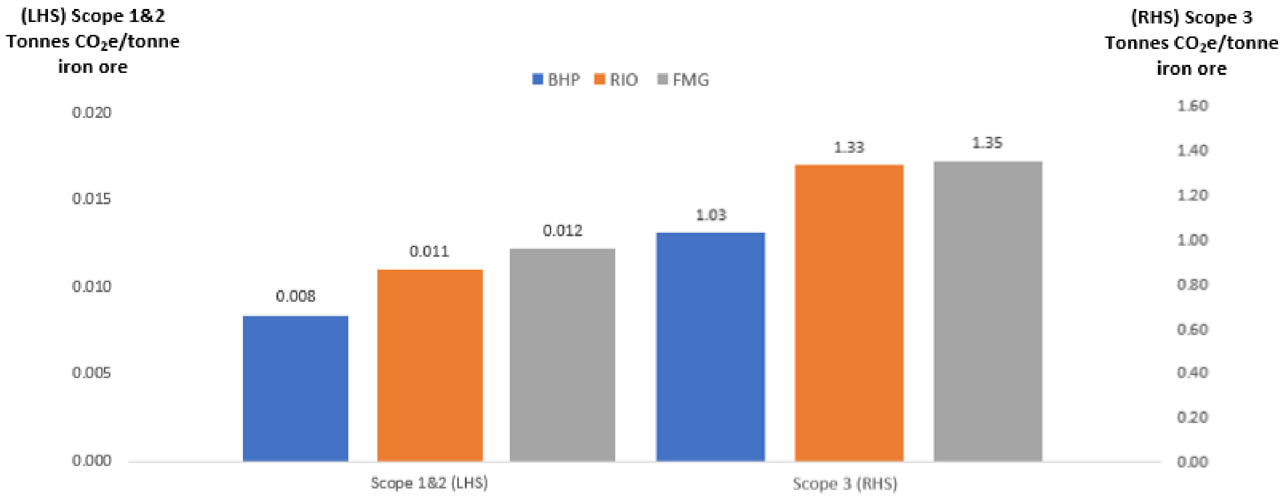
While each producer operates in a similar geographic locale of the Pilbara and all three rely on similar extraction and transportation systems, their emission intensity varies. This is mainly due to each producer's resource quality, both in terms of primary processing and then when converted into steel, such as:

1. Concentrated resources with lower strip ratios and within close proximity to customers require less mobile fleet to extract and transport them and therefore diesel usage.
2. Higher quality ores require lower processing (eg. dry vs. wet beneficiation when mined and therefore less energy).
3. Higher grade ores with lower impurities produce lower GHG emissions in a blast furnace when producing steel.

Data from BHP, RIO and FMG indicates that over the most recent financial year each generated 8, 11 and 12 t CO2e for each Kt of iron ore. BHP's scale and concentrated mining hubs as well as lower beneficiation are advantages over the other two producers.

On a scope 3 basis, the data between all three is less reliable. BHP and RIO use the same calculation methods for scope 3, however BHP splits these emissions between iron ore and metallurgical coal, while the others don't. FMG uses a different calculation methodology for Scope 3. In our view, FMG should have a higher scope 3 emissions GHG profile given the lower grade profile of its iron ore than peers.

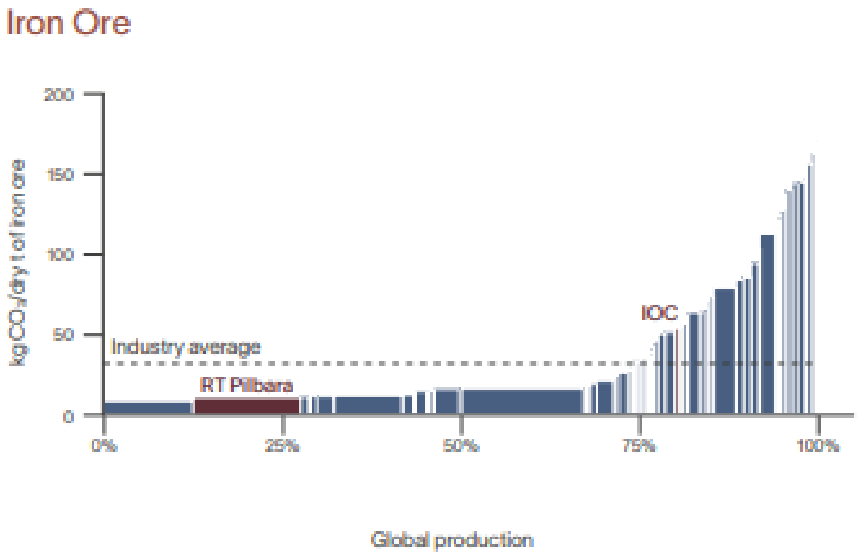
Emissions intensity per equity tonne



Source: Company reports & WaveStone analysis

On a scope 1&2 basis, all three Pilbara producers have the lowest intensity in the industry and are located in the bottom left of the emissions intensity cost curve for iron ore.

Iron ore emissions intensity cost curve - BHP, RIO & FMG are the least intensive miners at scale



Source: Rio Tinto

Irrespective of the starting basis all three producers are seeking to reduce their GHG emissions both on a direct basis (scope 1&2) and also to influence users to reduce theirs too (scope 3). A summary of the climate action plan for their overall businesses is presented below.

- FMG: Net zero operational emissions by 2030
- BHP: target: reduce scope 1&2 by 30% from 2020 to 2030 and a goal of net zero operational emissions by 2050
- RIO: reduce scope 1&2 by 50% by 2030 and a goal of net zero by 2050

BHP and RIO have scope 1&2 net zero Greenhouse Gas (GHG) emissions targets by 2050, while Fortescue Metals Group (FMG) has a more aggressive 2030 target for net zero. BHP and RIO's targets reflect their overall portfolio emissions including copper, aluminium and metallurgical coal and not just iron ore like FMG's.

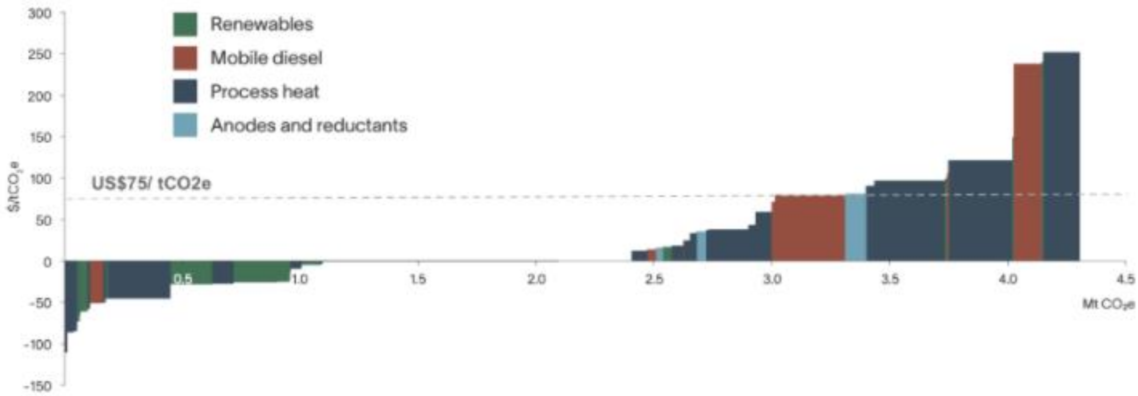
BHP and RIO's overall plans take into account the different aspects of their portfolios, with different timeframes depending on the marginal cost abatement curve and other factors such as technology advances and asset replacement cycles. However, with respect to the Pilbara operations of BHP, RIO and FMG their emissions profile is similar, as is the task of decarbonising them.

Despite differences in relative intensity, the method of scope 1&2 GHG emissions generation are very similar for all three companies which speaks to a broadly similar mining, processing flowsheet and the proximity of China (the biggest consumer of Iron ore) to the Pilbara. Around 25% emanate from stationary power with the remaining 75% from diesel use in rail and mobile fleet.

Over recent years we have observed that renewable stationary power has become increasingly competitive versus traditional means for mining companies. Below, we can see that under Rio Tinto's marginal abatement curve that this is indeed the case, where on a net basis an investment in renewables is expected to have a positive return on project economics irrespective on a carbon-tax being applied.

The same curve suggests that replacing GHG emissions caused by mobile diesel fleet is not economic at present unless a significant carbon penalty is assumed. Our understanding is that while fleet electrification is possible, the technology isn't likely to be mature enough to deploy at scale until the early 2030s.

Rio Tinto's total group marginal abatement cost curve



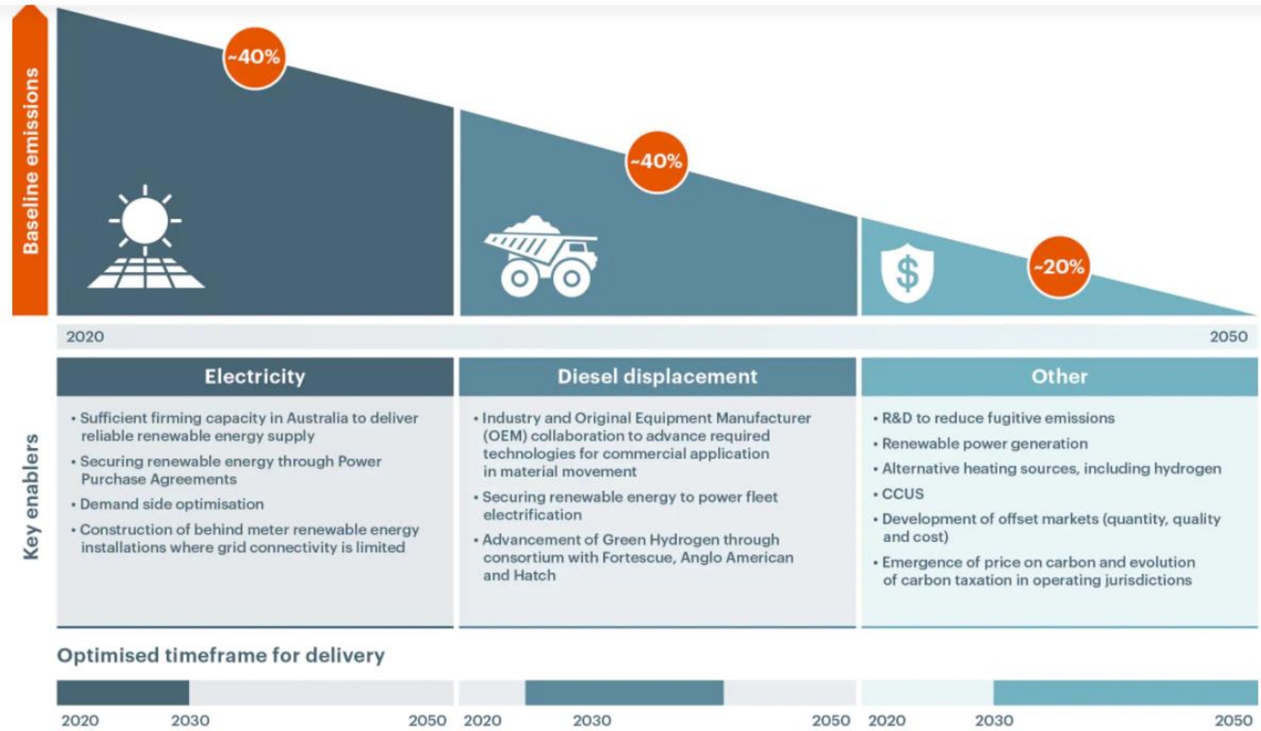
Source: Rio Tinto

With this in mind, it's not surprising that Iron ore miners are initially seeking to replace their existing stationary power with renewable energy systems and then attack GHG emissions from mobile fleet later in the decade. Interestingly, producers will need to continually invest in renewable energy infrastructure ready for a scaled electrified mining fleet at this time.

Buy or Build yourself

BHP and RIO are technology indifferent to deploying technology, seeking to partner with original equipment manufacturers (OEMs) such as Caterpillar, Komatsu and Hitachi for trucks and diggers and Caterpillar and Wabtec for trains. For stationary power, this strategy is similar in using reputable OEMs for equipment with the exception is that Rio Tinto will directly invest in its own power resources, while BHP's preference is to contract with others for emissions free electricity and not deploy capital into these assets. We see merits in the approach of both strategies (buy vs. build) particularly for assets such as iron ore, which have long mine lives enough to defray the initial capital cost of the build out.

BHP's GHG emissions reduction plan



Source: BHP

FMG has adopted a different approach to reducing their GHG emissions. The company aims to capture economic rent available from decarbonisation by becoming an investor in fixed infrastructure, energy products (such as hydrogen) and also become an OEM of mobile fleet such as battery electric trains. As an added constraint to this strategy is a target of net GHG emissions neutral by 2030 (only eight years away) and technologies that require extensive field testing.

FMG's approach to us appears risky. Investing in off-the-shelf technology to electrify its iron ore operations appears valid, much like the current Pilbara Energy Connect project that FMG is undertaking. However, by going further up the value curve as an OEM supplier of trains or mining fleet, FMG competes against the power of significantly larger players such as Caterpillar and Komatsu with extensive R&D budgets and customers ready to partner with them. Further, clean fuels such as hydrogen still appears risky to us at this point in the cycle.

Fortescue's decarbonisation pathway

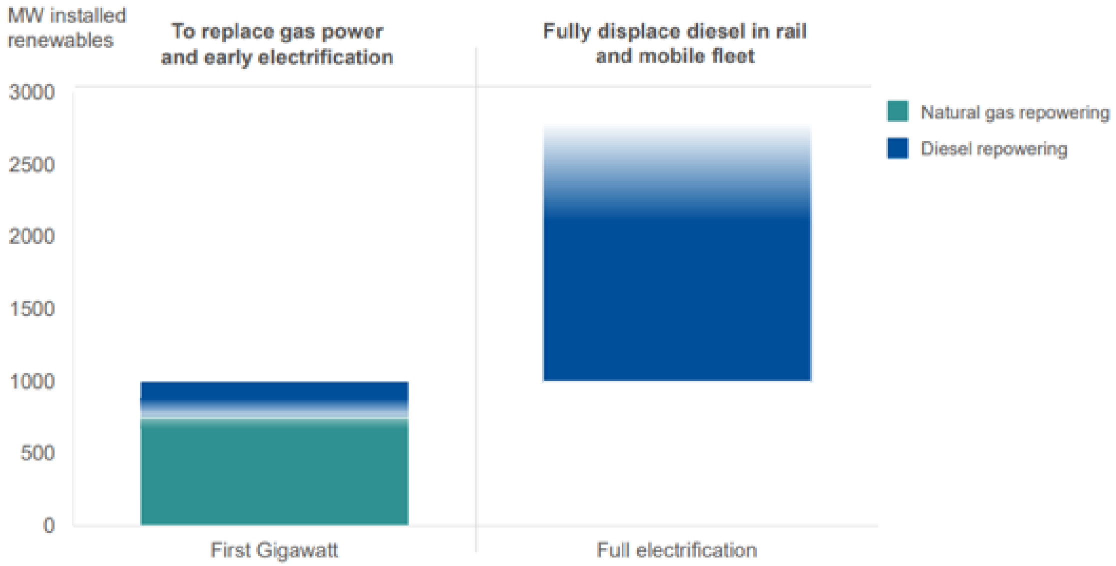
Source: Fortescue Metals Group

Example: Replacing stationary power
Rio Tinto has announced that to replace its 480MW of gas fired stationary power systems and some early mobile fleet electrification (and reduce 1.1MtCO2e p.a.) of GHG emissions, the company will install approximately 1.0GW of wind, solar and battery investments with an initial investment of approximately US$1.5b by 2030. The offset for RIO is an annual saving of circa $120m in displaced gas costs when renewable energy begins generating.

At this stage RIO believes further investment of at least 1.5GW ($US2.3b) would be required to provide power RIO's mobile fleet electrification program including all trucks, mobile equipment and rail operations.

However, we consider this to be an early-stage assessment. Adding to the fixed investment in new power sources would be the capex to replace over 1,000 pieces of mobile equipment in operation including some ~370 haul trucks, excavators and drills. Considering $5m for each truck would involve an expenditure of $2b alone! With this in mind it's no wonder such a move would require a carbon price subsidy of at least $75/t to be NPV neutral (although this replacement won't occur immediately and could be considered within the scope of normal maintenance capex).

Rio Tinto’s renewable deployment pathway

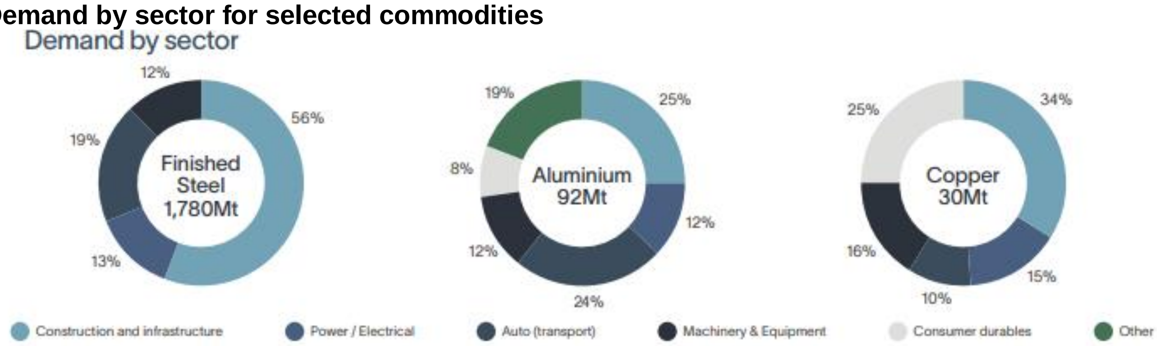


Source: Rio Tinto

Scope 3 emissions

Shifting our focus downstream to scope 3 emissions, in this case emissions generated from steel manufacturing, the chart below sets out demand for steel, aluminium and copper. For steel we can see that it is a significant material used in the construction, power, auto and machinery sectors of today's economy with demand growth heavily influenced by the megatrends of urbanisation and increasingly the energy transition. Indeed, BHP estimates that over the next 30-years steel demand will grow at around 1.5-2x vs todays total demand of 2 billion tonnes.

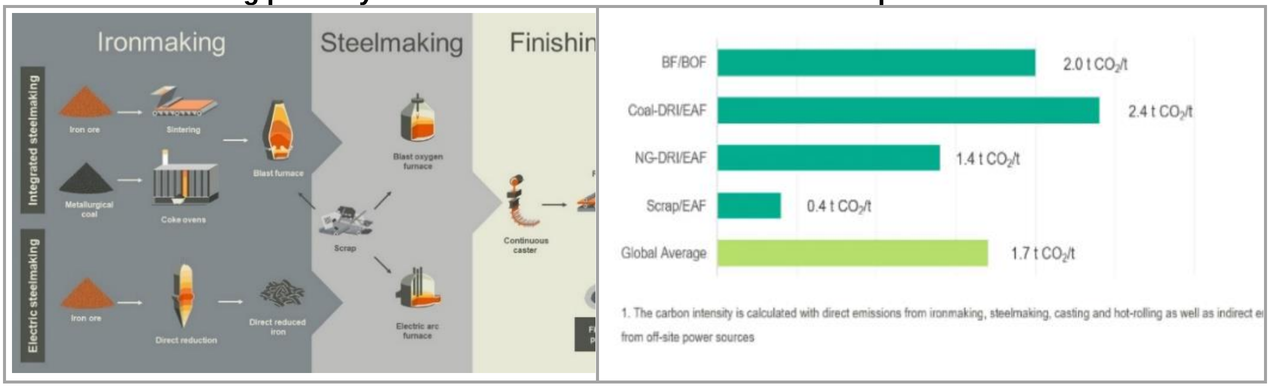
Demand by sector for selected commodities



Source: Rio Tinto

The process of converting iron ore into steel is done at high temperatures and emits significant GHG emissions at between 1.4t CO2e/t for direct reduction to 2.0t C02e/t for a traditional blast furnace as we can observe in the charts below. In total, the sector emits nearly 3.7Bt of C02e emissions globally or around 8% of total emissions.

Steel manufacturing pathway and relative GHG emissions from each process



Source: BHP

Steel sector decarbonisation pathway

As a major emitting sector, the steel industry is under pressure to reduce emissions. The conundrum facing the sector to do so is that decarbonisation faces the challenges of:

1. Availability of and cost of clean fuels to replace the current integrated method of producing steel.
2. Availability of scrap, high quality ores and scalable renewable energy for Direct Reduced Iron (DRI)/Electric Arc Furnace (EAF) technologies to expand its market share.
3. The significant capital cost of building a new blast furnace at US$4b per 2Mt of steel capacity vs. a typical $50m-$100m relining (maintenance) program once each 10-years. This is especially when combined with a relatively young fleet in China and India, the world's largest and fastest growing steel producing regions.

Steel by region and age of blast furnaces

	Crude Steel (Mt)	Global Share (%)	BOF Share (%)	EAF Share (%)	DRI in EAF (%)[2]	BF plant age[3] (years)
China	996	53.3	90	10	1	12
European Union	158	8.5	59	41	6	45
North America	119	6.4	32	68	14	53
India	111	6.0	44	56	57	18
CIS[1]	100	5.4	65	29	17	50
Japan	99	5.3	75	25	0	44
Korea	71	3.8	68	38	2	27
ME & Africa	60	3.2	10	90	87	42

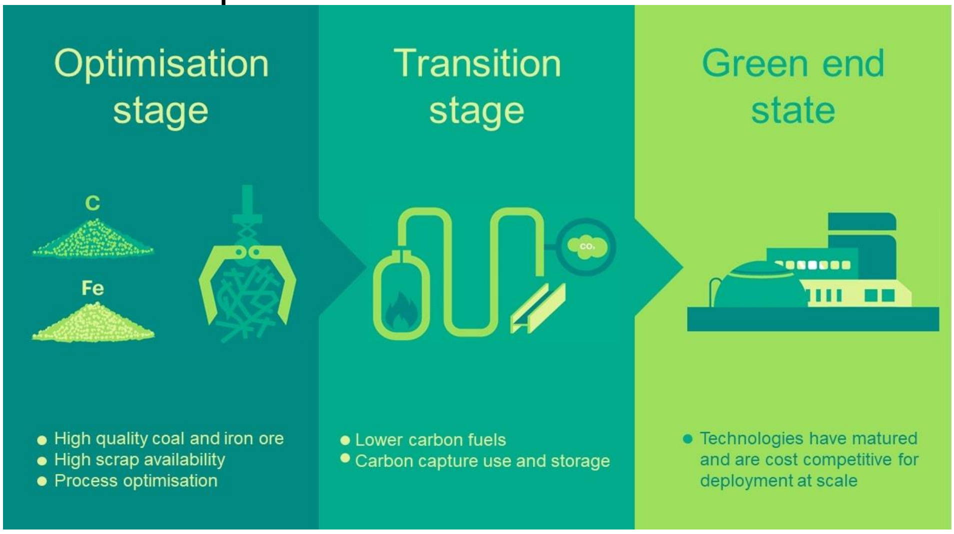
1. CIS has a BOF + EAF share of 93%, with the remaining 7% being Open Hearth Furnaces (OHF)
2. Estimated Direct Reduced Iron (DRI) consumption (production + net import) / EAF production
3. Regional capacity-weighted average age for the integrated steel plants. This is a sample estimate, not a census of all operations.

Source: BHP

That said, even with the above constraints there are pathways to reduce emissions intensity. BHP has set out a plausible pathway for GHG intensity reduction below – with key steps of optimisation (20% reduction), transition (40-50% reduction) and green end state with no emissions.

In our view, despite the above significant reductions on offer on a per tonne basis it will be challenging for the aggregate sector emissions to fall given the expected demand for steel in future years and a lack of substitutes for this material.

Decarbonisation plans for the steel sector



Source: BHP

Digging deeper into the decarbonisation journey, we see optimisation as low hanging gains that can be available to all steel manufacturers and offering a cut of 20% to a Basic Oxygen Furnace (BOF) process. Initially these gains can win by capturing fugitive emissions, increasing scrap utilisation and increasing the demand for high quality iron ore and steel (thus making each furnace more efficient). The real-world constraints on furnaces from introducing these changes include a scaled renewable energy solution and access to high grade iron ores. On the latter front, despite worldwide grades declining, we see a role for greater beneficiation of iron ores, particularly with the advent of more renewable power sources, particularly in areas that can deploy them at scale such as the Pilbara.

If the industry could remove 20% of its GHG emissions from the above phases, this 740Mt reduction would be ~10x the total scope 1&2 emissions from the extraction of iron ore alone – it's a big prize!

Carbon Capture and Storage (CCS) is likely going to become a reality for the industry in the transition phase. As renewable stationary power systems increase their cost competitiveness, these systems are also likely to be deployed and directly capture emissions from a steel mill. Further, CCS enables other non-carbon fuels such as direct oxygen injection, which also lowers GHG emissions from a furnace. Thus, existing integrated BOFs can continue operating, but with significantly lower emissions – reported at up to 50-60% in aggregate or nearly 1.5Bt of emissions. As this situation evolves it is likely that demand for high grade iron ore remains, especially from producers which have a low GHG footprint themselves.

Turning to clean fuels and the green end state, which is the ultimate goal, it's unclear how this journey will play out. For example, while direct reduction with hydrogen is talked about, the technology is not mature and very costly both from a fuel's perspective, but also high-grade ore availability, which is essential to the DRI process itself.

To expand on the quality angle. DRI is a process that reduces iron ore in its solid-state using hydrogen and carbon monoxide, which is then melted via EAF. Ores used in this technology have to be high grade +65% iron and have low impurities for the process to work economically. At present only 100Mt out of 2.2Bt of global iron ore production is used in the DRI process, with the growth of this production limited by the in-situ resource base quality and the cost of upgrading it to higher grades.

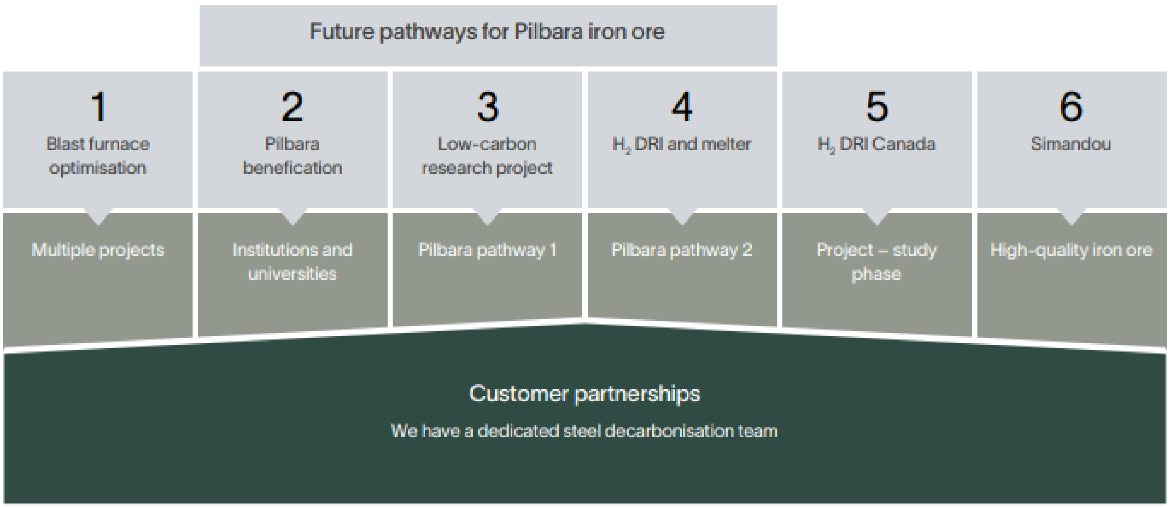
That said, as technology advances and carbon taxes eventually levied, we are likely to find a breakthrough of some description for low emissions steel making in addition to those gains afforded by optimisation and transition. In our view, the countries where we see the most opportunities for early adoption are those with 'old' blast furnace fleets such as Europe (8.5% of global steel production) which require replacement within the next 10-20 years, compared to those with new fleets such as China (53% of steel production). Given China's large market share in steel (and even more so in iron ore due to its heavy use of blast furnaces) demand for iron ore for the Pilbara iron ore producers is expected to remain significant.

So where does this leave the Pilbara Iron Ore producers?
The current status quo of the sector is likely to evolve, but it will take time. We assume that each of BHP, RIO and FMG decarbonises their scope 1&2 emissions, with some drag on NPV from the implementation and timing of these measures (it's easy to say rollout 1GW of renewable energy but challenging to actually do it). As demonstrated by the CO2 intensity curve, the three Pilbara miners are well placed to remain competitive suppliers in the future even after their investments are made.

Pilbara producers are busy establishing partnerships with steel producers and technology providers to assist the steel producers reducing their GHG emissions. These partnerships are important as they allow the sector to transition into a lower emissions state with considerations on technical limitations across the value chain and also an achievable planning timeline to do make the appropriate pivots. For example, a new iron ore mine takes 10-years from identifying to build to operation, so planning is key before FID is taken on a new development.

We have presented RIO's future iron ore pathway in the picture below. Partnerships are the bedrock of RIO's approach, with multiple avenues the company's future investment and production could take. For example, an investment in the Simandou iron ore mine would increase RIO's opportunity to produce iron ore suitable for DRI/EAF process vs. an incremental investment in a new Pilbara iron ore mine which wouldn't be able to fulfil the technical requirements of this process without further beneficiation.

Rio Tinto iron ore pathways



Source: Rio Tinto

As we continue along the progression to lowering steel GHG emissions, one thing continues to stand out. Through the optimisation, transition and green state, the demand for high quality iron ore is likely to only grow at the expense of those low-quality ones given these ores allow the sector to either optimise their current processes and transition to a new green state – processes not achievable with low quality ores. We also can see that for BHP, FMG and RIO (as well as others), future plans need to account for the evolving industry dynamic and are likely to result in a quality over quantity approach that occurred over the last decade, so as to avoid the risk of stranded assets.

Carbon Emission and Intensity Tracker:

WaveStone - Australian Share Fund (WASF)	Carbon Emissions Scope (tonnes CO2e)		
	Scope 1	**Scope 2**	**Total**
Portfolio – WASF	17,707	5,382	23,089
Benchmark - S&P ASX 300 Accumulation Index	34,330	11,086	45,416
Difference	**-48.4%**	**-51.5%**	**-49.2%**

Source: MSCI ESG (as at 31/03/2022)

WaveStone - Australian Share Fund (WASF)	Carbon Intensity Scope (tonnes CO2e/sales)		
	Scope 1	**Scope 2**	**Total**
Portfolio – WASF	93.2	28.3	121.5
Benchmark - S&P ASX 300 Accumulation Index	111.4	54.8	166.2
Difference	**-16.4%**	**-48.4%**	**-26.9%**

Source: MSCI ESG (as at 31/03/2022)

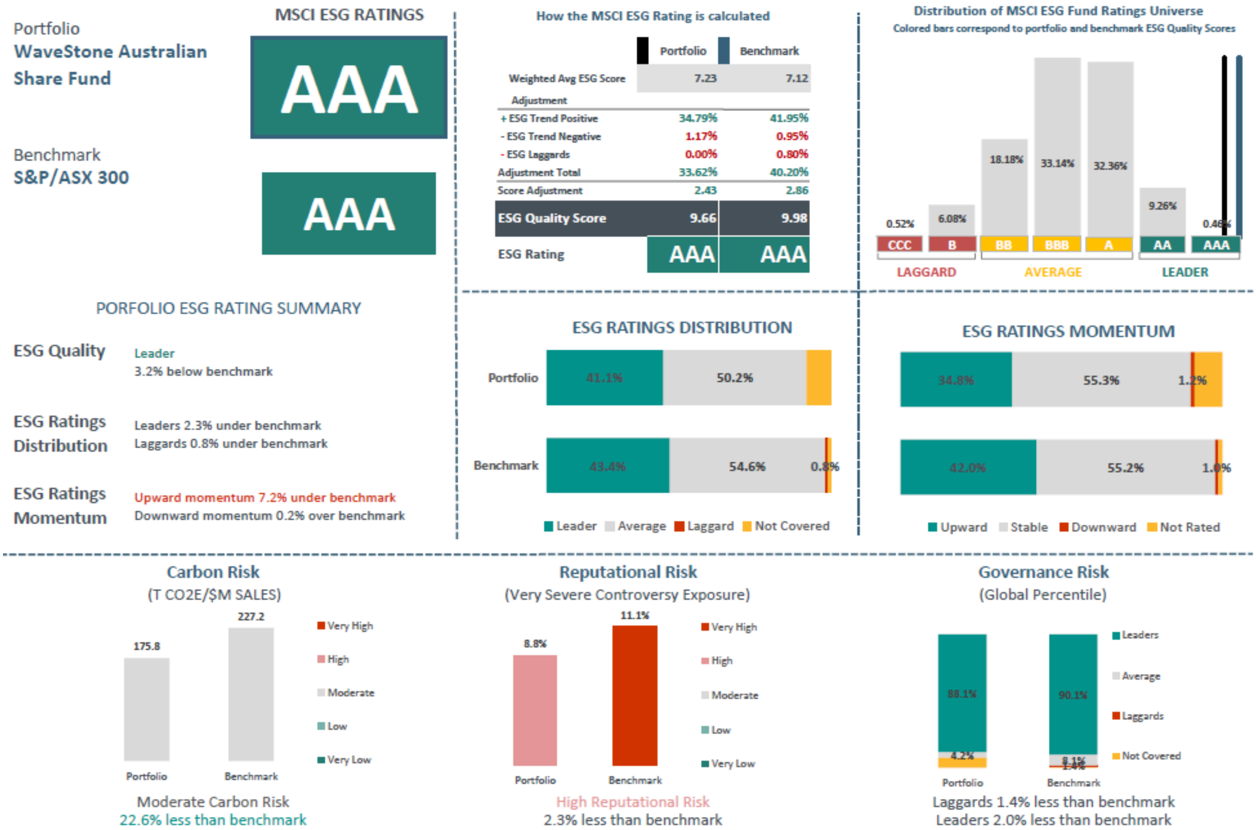
Engagement

ESG-related Engagements during the Quarter

Company	ESG Category	Topics
ALL	Social Governance	Russia/Ukraine war impact on business & employee safety
APM	Social Governance	REM / Culture / Risk Management and Compliance / Vision 40:40
BHP	Environment	How BHP Ni re-establishes itself to grow Ni Sulphides for Battery market. How growth objectives will occur in line with CTAP
CKF	Social	NSW/QLD floods impact, employee safety, inflation and food sourcing
CSL	Governance	Vifor. Understand the why behind the Vifor acquisition
CWY	Social	1-1 Following 1H22 Result / Group Strategy / Diversity
First Quantum	Industry Engagement	Understand practical implications to moving mining fleet to electrification
FMG	Environment	Discuss operating performance / Decarbonisation including FFI
IGO	Governance	General catch up / Strategy and governance at TLEA JV
ILU	Industry Engagement	Rare earths opportunity as part of Aus critical minerals strategy
MIN	Environment	Understanding constraints/opportunities in Li market
Mitsui	Industry Engagement	Mitsui evolving investment strategy given climate considerations
NST	Environment	Strategy / Decarbonisation and climate change objectives / Governance
PLS	Industry Engagement	General catch up on company and Lithium industry / Export of low grade Li units to Europe and C02 generation vs. more value added products in Australia
QAN	Social	1H22 Result / Strategy / Baggage handlers and Justice Michael Lee ruling

RED	Environment Social Governance	Growth objectives /Strategy and understanding of how sustainability plays a part of that
RIO	Environment Social Governance	Voting / HR report and Juukan Gorge fallout / Unpick company culture and heritage issues
s32	Environment	Corporate strategy including portfolio evolution and climate risks on assets and cost of capital
STO	Environment	STO climate change forum to discuss evolving plan to lower emissions
SVW	General	FY22 results review / Climate change / BLD Governance
TCL	Social Governance	Company strategy update / Establish basis of FY22 REM outcomes given WGT settlement / Board and Management succession / Tolling Reform
TPG	Governance	Strategy / 2022 Escrow considerations
WPL	Environment Governance	Company strategy update in-line with BHP Petroleum merger and new climate change goals

MSCI ESG Ratings*



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Memberships and initiatives

- Principles of Responsible Investment (PRI)
- Climate Action 100+
- 40:40 Vision

Links to WaveStone Policies

- ESG Policy: **WaveStone ESG Policy**
- ESG Activity Report: **WaveStone ESG Activity Reports**
- Proxy Voting Policy: **WaveStone Proxy Voting Policy**
- Proxy Voting Records: **WaveStone Proxy Voting Records**
- Engagement Policy: **WaveStone Engagement Policy**
- **WaveStone PRI Transparency Report 2020**
- **WaveStone PRI Assessment Report 2020**

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