Steeling the Future

The truth behind Australian metallurgical coal exports

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Contents

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Steel cities in China's Hebei Province

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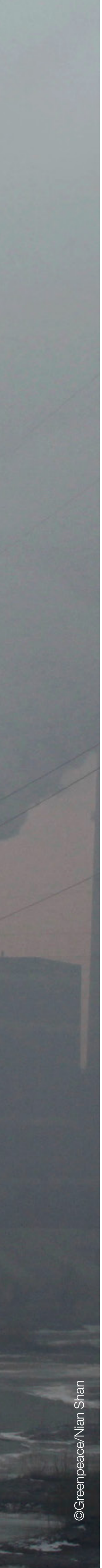
Australia's continued expansion of metallurgical coal exports is hindering the global uptake of cleaner steelmaking alternatives.

Clouds of smoke billow from under the haze in the gloomy sky in China, Shanxi Province.

Australia is in a unique position to lead sustainable global change in the steel industry.



1

Executive summary

This report highlights the role that Australia's metallurgical coal exports have played in the increasing global use of blast furnace/basic oxygen furnace-based steel production, the most greenhouse gas emission intensive process to produce steel. It challenges the coal industry's position that metallurgical coal is essential for steel production, and argues that **Australia's continued expansion of metallurgical coal exports is hindering the global uptake of cleaner steelmaking alternatives.**

Australia should learn from its experience with the thermal coal industry. Global thermal coal production is in structural decline. The Federal Government's failure to anticipate or accept the decline of thermal coal has resulted in negative impacts for coal communities, which have experienced substantial job losses and have been left without any plan for how to adapt to market realities and transition to other forms of economic activity. The Turnbull Government has an opportunity to avoid such an outcome

Abbot Point Coal Port Expansion in North Queensland

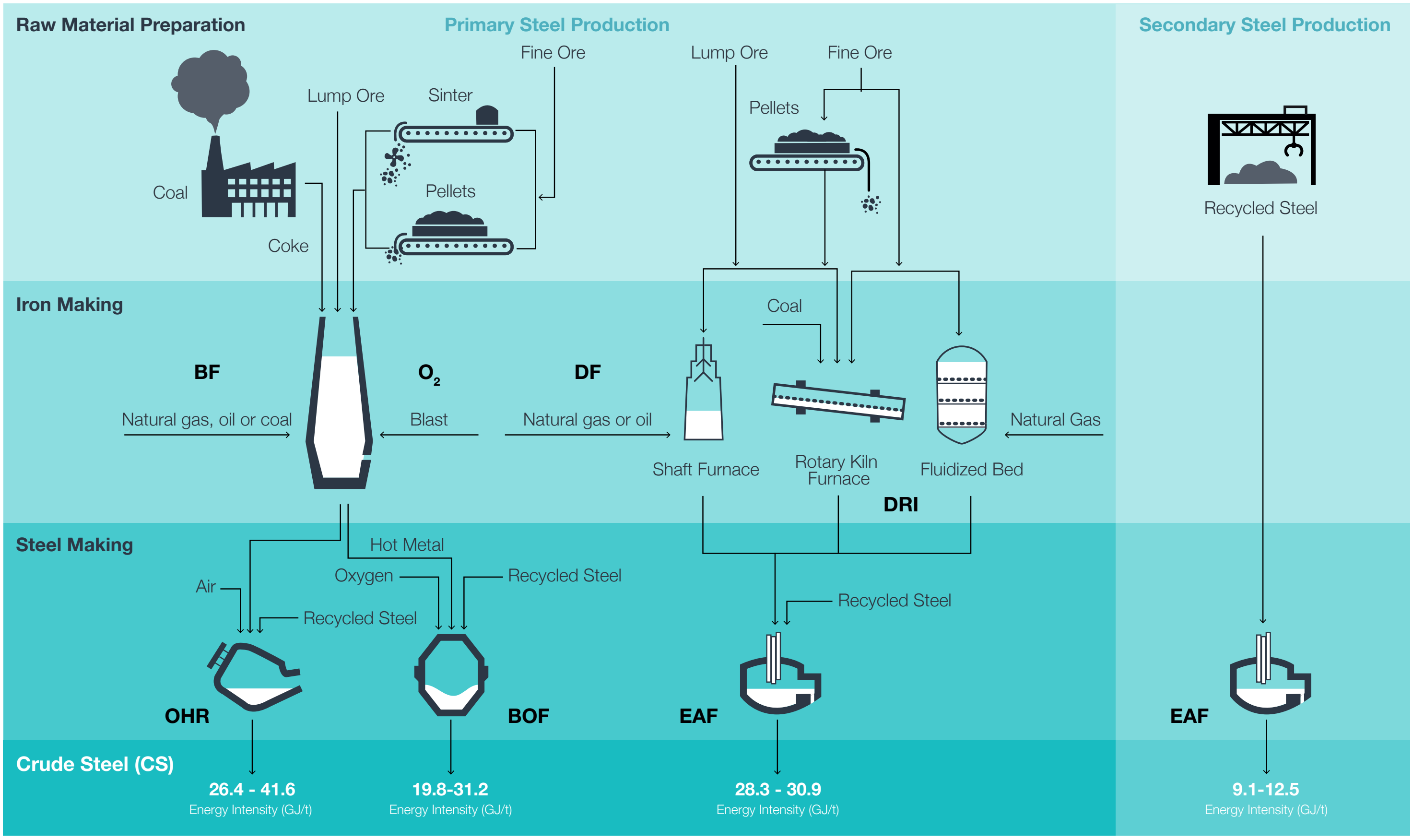
for communities currently reliant on the metallurgical coal industry by developing a transition plan for the decline of metallurgical coal and a shift to cleaner steel production right now. By planning ahead, Australia could position itself as a technological leader in the field of clean steel production while also ensuring that it makes a meaningful contribution to global efforts to combat climate change.

2

Australia's dirty role in global steel production

Few Australians appreciate the dirty role their country plays in world steel production. Most don't know that nearly half of Australian coal exports go to making steel, or that Australia earns a lot of money selling metallurgical coal.[1] In the past 15 years Australia has ramped up 'met coal' exports (along with iron ore exports) and played a central role in fuelling a steel boom in China—the likes of which the world has never seen. Now the Australian met coal industry wants to do the same in India.[2] The industry claims that metallurgical coal is indispensable to steel production and that there won't be a viable large-scale alternative to coal-based steel production for decades to come. 'But it's for steel' has become the perfect excuse to expand met coal exports, ignoring all the emissions that this creates.

Met coal and iron ore are the main inputs of conventional steel production via the blast furnace/basic oxygen furnace (BF/BOF) route—the most emission intensive option. The coal is turned into coke and used to reduce iron ore into a metal. The much cleaner route to produce steel uses an electric arc furnace (EAF) fed with either scrap steel or direct reduced iron (DRI). DRI generally uses natural gas rather than coke as the 'reductant' to make iron.



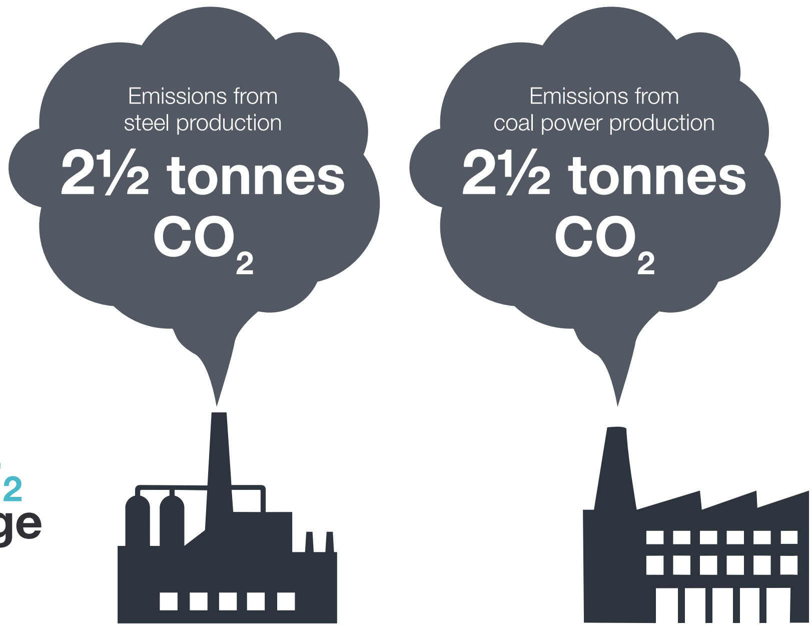
Office of the Chief Economist 2017

Since 1997 Australia's coking coal exports have increased from 83.7mt to 188mt – a 122 % increase.[3] Over the same period, there's been a more than five-fold increase in Australian iron ore exports to well over 800mt.[4] Of the met coal increase, over 90% has come from China and India.[5] We have become the largest source of imported met coal in both countries.[6] It is not the first time that Australia has used its plentiful reserves of met coal and iron ore to drive steel production in our region. The iron ore mining industry in Western Australia and many coal mines in central Queensland have their origins in the rapid expansion in steel production, particularly by Japan in the 1970s and 1980s.[7] Australia has derived substantial economic benefits from this trade, and the emergence of China and India as rapid growth markets for met coal and iron ore could not have been timed better from an economic standpoint—coming as steel production in traditional markets waned.

From an environmental standpoint, however, the timing has been disastrous. Accounting for one in every fifteen tonnes of global greenhouse gas emissions, the impact of steel production is generally underappreciated.[8] Perhaps because met coal isn't burned in steel mills, but used as a 'reductant', the connection between met coal and emissions isn't as easily made. However, with each tonne of coal used in steel production generating on average the same 2 ½ tonnes of CO_2 as a tonne of coal burnt in a power station, Australia's met coal exports warrant closer attention than they receive.[9] Today Australian met coal exports produce nearly half a billion tonnes of CO2 offshore--88% as much greenhouse pollution as is produced domestically.[10]

Whereas met coal is a much smaller contributor to global emissions than thermal coal, it is a disproportionately large component of Australia's contribution. Australia accounts for around 60%[11] of all the met coal trade, and in the past 20 years, it's accounted for about 90% of the net increase seen globally.[12] Others have increased exports of iron ore and/or met coal – most obviously, Brazil has more than doubled its iron ore exports since the year 2000[13]. But no other country has increased exports of both iron ore and met coal the way Australia has. Partly as a consequence, scrap steel recycling rates in China remain among the lowest in the world at about 10%—1/5th of the rates being achieved in the EU, 1/7th of the US.[14] Our actions have also helped China dominate the global steel trade, contributing to the current glut in production. Chinese gains have come at the expense of cleaner steel industries elsewhere.

In essence, Australia has played a key role in enabling the global steel industry to become more, not less, emission intensive. It's not a situation that has fallen in the lap of the 'lucky country'. Australia deliberately sought and won its position as the world's pre-eminent facilitator of the dirtiest steelmaking process. Successive governments on both sides aided expansion of the iron ore and coking coal export industries. They've knowingly profited from a strategy that has helped to dramatically increase global steelmaking emissions, and disowned the consequences.

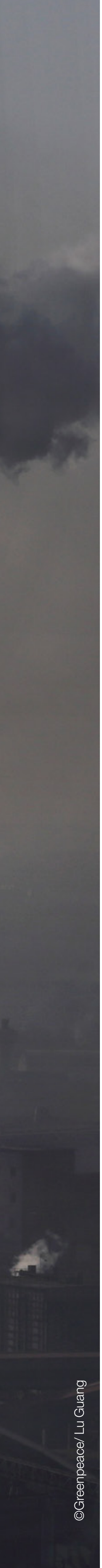


For every tonne of coal used at either plant

2½ tonnes of Co_2 are emitted on average

Australia's dirty role in global steel production

In Hebei Province, smoke billows from chimneys from the steel plants. Air pollution has become one of the most severe environmental problems in mainland China.



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Locking in future carbon emissions

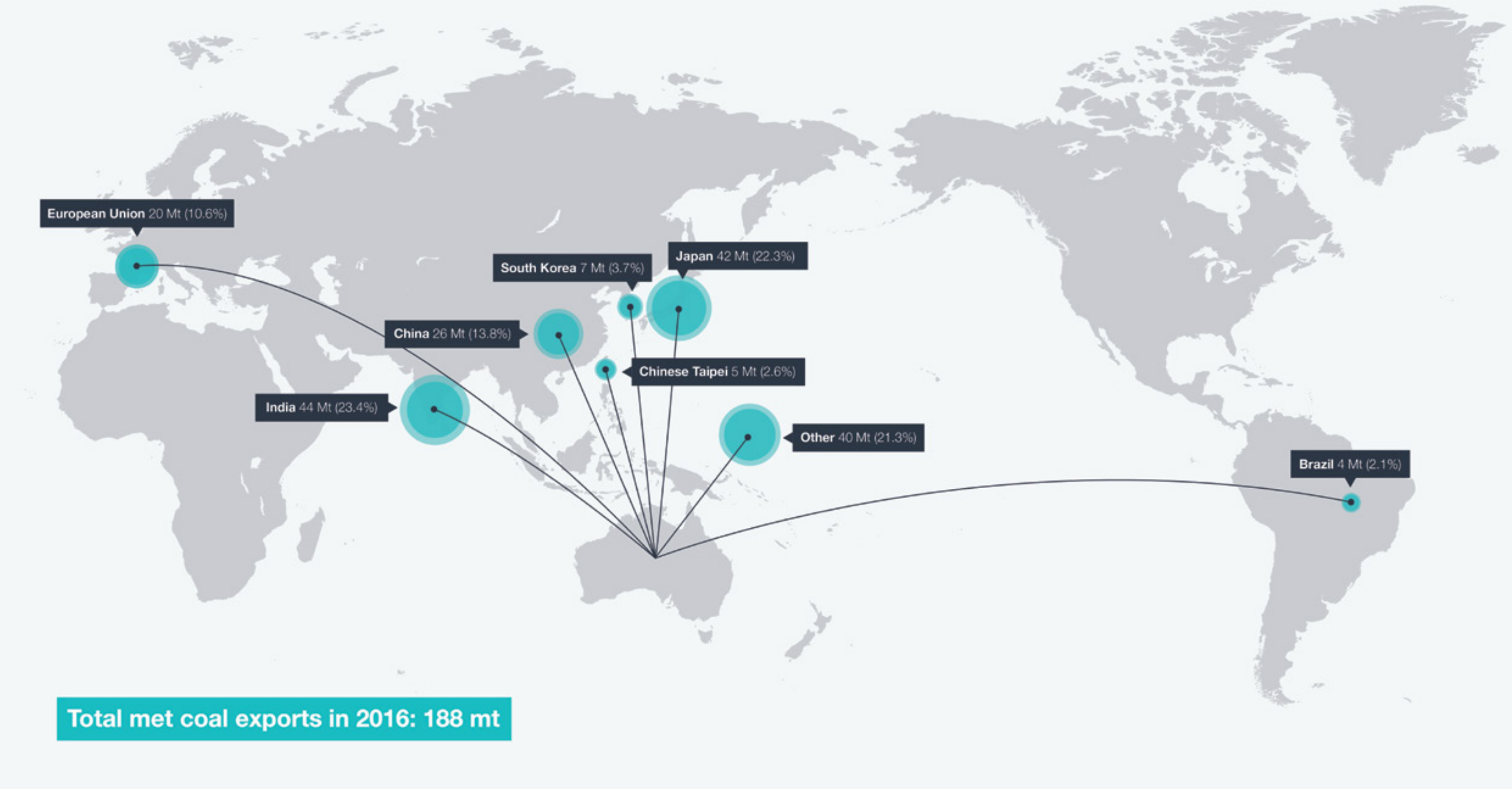
There are strong parallels between electricity generation and steel production when it comes to climate change. The dominant and dirtiest option in both industries relies on coal. In both cases, the coal industry wants us to believe that coal is indispensable, and will remain so for decades. However, in both cases cleaner alternatives have been proven on an industrial scale, are commercially viable, and are increasingly cost competitive.

In the electricity sector, the falling cost of renewable energy is eroding the business case for new coal-based power generation capacity, especially in developed countries. Renewables and natural gas already account for some 44% of global generation.[15] In the steel sector, over 430 million tonnes, or 25.8% of crude steel produced globally comes from the EAF process in which coal is not essential.[16] In practice, coal may play a part – much of the scrap steel being fed into EAFs originated in a coal-based blast furnace, and coal-fired electricity drives many EAFs. But the process itself doesn't need coal – electricity could come from other sources, including renewables; the scrap steel itself could be replaced entirely with gas-based DRI. Worldwide, nearly 60 million tonnes of DRI is being produced annually without coal.[17] The shift away from BF/BOF steelmaking has been most notable in developed countries. For example, in the US, where the last new coal-based blast furnace was built in the 1960s[18], more than 62% of steel comes from scrap based recycling in EAFs, compared with 37.2% thirty years ago.[19]

However, the picture is quite different in China and India, where the mass migration of hundreds of millions of people from country to city has generated huge new demand for steel and electricity. Cities have had to be built and powered quickly. The demand increase necessitated massive investment to add electricity generation and steel production capacity. Power had to be produced locally – importing electricity wasn't an option; and the scale of increased demand for steel, especially in China, was simply beyond the capacity of world steel market. In China, installed coal fired power generating capacity more than trebled after 2000; steel production increased more than fivefold.[20]

Steel cities in China's Hebei Province

While the general trends for electricity and steel production have been running in parallel, they diverge when it comes to greenhouse gas emissions. In electricity, the impact of increasing demand in some parts of the world has been partly offset by declining demand and a shift away from coal in developed countries. In China, and in India, there have also been concerted efforts to diversify new electricity generation across nuclear, natural gas, and some of the world's largest renewable energy projects. Any new coal based capacity added in China has also been much more efficient, and less emission intensive, than the decades-old plants being retired in developed countries (this is less true for India).[21] The overall result is that emissions from electricity generation worldwide are levelling off.[22]



Yet, the opposite happening in steel—the new capacity being added, especially in China, hasn't been relatively cleaner – overwhelmingly it's been coal-based BF/BOF facilities. Compounding the emission consequences, Chinese steel production has expanded so successfully that it has not simply met its own spiralling domestic demand—it has displaced other producers in the global steel trade. Today, China not only tops the list of steel net exporters, it exports more than the 5 countries behind it on that list.[23] So, there's been a wholesale shift in steel production away from the developed world, but also away from the cleaner production process to the dirtier one.

In total, worldwide, steel production increased from 847mt in 2000 to 1.62bt in 2015.[24] BOF accounted for around 90% of the increase.[25] Coal-based steel production increased its share of global crude steel production from under two thirds to nearly three-quarters,[26] adding over 2 billion $MtCO_2$-e to global annual emissions in the process.[27] In China, coal-based BOF production increased by 675mt, EAF production by just 28.8mt.[28] The BF/BOF share of all steel production rose from 63% to 94%. For every tonne of newly added Chinese steel produced in EAFs since the year 2000, over 23 tonnes have been added by the dirtiest coal-based steel-making processes. Today, the global steel market is flooded with cheap Chinese steel made in the dirtiest possible way, and the burgeoning demand for steel in developing countries is becoming more reliant on the dirtiest form of steel production, not less. Electricity generation is getting cleaner globally, but steel production is going the other way.

Though it is counter-intuitive that steel production should get dirtier in the face of climate change, various factors have contributed. One is that until relatively recently the Chinese 'reservoir' of scrap steel available for use in EAFs was considered inadequate.[29] There also wasn't the same public concern over air quality driving Chinese investment into low-emission steel production as helped to drive renewable energy investment. But cost is the overriding factor: BF/BOF was China's cheapest option. The main inputs to the process – iron ore and metallurgical coal for making coke – are readily available locally, and the willingness of various countries to increase supply on the seaborne trade makes BF/BOF even cheaper still. Global iron ore exports trebled from 500mt in the year 2000 to 1.51bt in 2015[30]; met coal exports have increased from 170mt to 315mt over the same period.[31]

For China, and for the met coal industry, the past 15 years have been an unexpected bonanza. Twenty years ago, as the alarm bells over climate change were getting louder, it was assumed that EAFs would provide a growing share of increased steel demand worldwide.[32] Instead of the steady switch away from coal-based steel production that was expected, the opposite has happened. For the coal industry, the met coal demand boom has been a lifeline. The industry was resigned to stagnant or shrinking demand in developed countries. Now, just as the coal industry's hopes to expand thermal coal sales are pinned on developing countries, particularly China and India, met coal's expansion depends utterly on more and more blast furnaces in those countries.

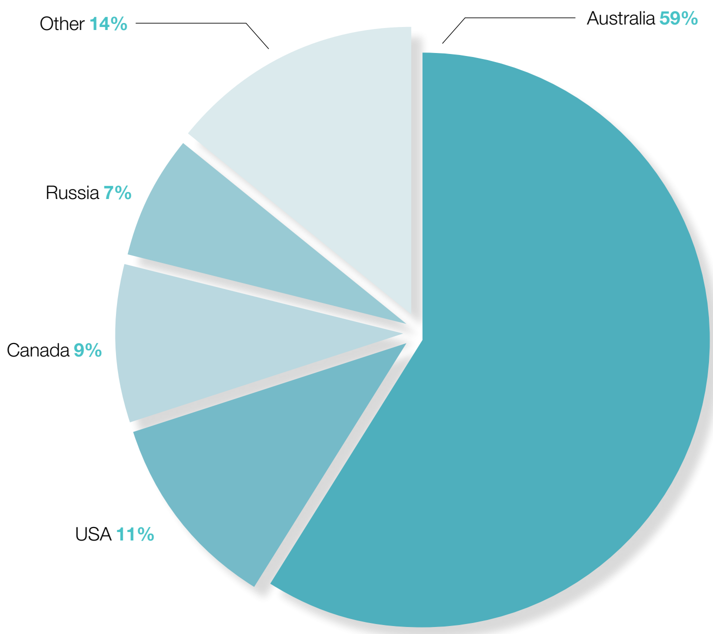
Bulk Carriers Moored off Hay Point at Great Barrier Reef

Enormous damage has been done, but the stakes remain very high in the decade ahead. Steel production is tipped to increase from 1.6bt a year to 2bt in 2030 – a 25% increase.[33] The emissions outcome will largely come down to what happens in India in the next decade. China remains significant, but production is levelling off, and scrap steel use in EAFs is gaining momentum. By contrast, most of the projected growth in global steel production projected by 2030 is likely to happen in India, where a more than trebling in steel production has been targeted by the government.[34] At present, EAFs account for nearly 60% of steel production in India.[35] But the met coal industry is looking to reverse that situation, and replicate the BF/BOF-dominated expansion seen in China in the past 15 years. If the coal-based expansion seen in the past 15 years happens once again, new facilities will be largely locked into coal-dependency, and annual steel industry emissions could rise by another billion tonnes.[36]

If, on the other hand, new production is dominated by EAFs fed with either scrap and/or DRI made with alternative reductants to coal, 75% or more of the emissions increase can be prevented.[37] For every tonne of steel scrap used in an electric arc furnace, 98% less coal is required compared with the conventional BF/BOF alternative[38]; for every tonne of crude steel produced via the DRI/EAF route, the amount of CO_2 produced is cut by around 75%.[39] New facilities aren't the only thing that matters. There's substantial scope to reduce emissions from existing BF/BOF facilities: by using more scrap steel and DRI in blast furnaces to reduce iron ore and met coal use, and by replacing met coal with sustainably sourced charcoal (from forestry and agricultural residues), and plastics waste. But ultimately, a further blow-out in steelmaking emissions over the next decade can't be avoided by retrofitting BF/BOF facilities; it requires an accelerated shift onto the scrap/DRI based EAF route, increasingly powered by renewable energy.

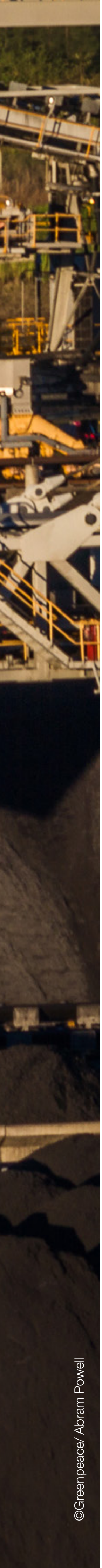
At present, so far as the climate is concerned, the dirtiest player in the steel game is still winning. The question is whether steel production will follow the path to increased coal-dependency that it's currently on, or the path away from coal-dependency being followed in electricity generation. For the former to happen the world has to start taking met coal as seriously as it takes thermal coal in its efforts to reduce greenhouse gas emissions.

Percentage of Global Met Coal Trade:



Source: Office of the Chief Economist 2016

Hay Point Coal Terminal in Queensland



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Transitioning to cleaner steel production

The world faces tough decisions about the growing trade in met coal exports as the link between it and spiralling steelmaking emissions becomes ever more obvious. It's hard to see how a country like Australia can credibly continue ignoring the emission consequences of its met coal exports any more than its thermal coal exports. Australia's decisions on whether to increase or reduce met coal production have increasing global consequences. If the met coal trade continues expanding, it will help lock in an extra billion tonnes of steel production emissions by 2030, and further hinder the transition to cleaner DRI and scrap-based EAFs. Conversely, the world can begin to wind down rather than ramp up its met coal production. Australia is in a unique position to lead sustainable global change in the steel industry because if it began withdrawing from the met coal export business, other countries would be unable to fill the gap in a hurry; Australia exports more coking coal than is imported by China, India and Japan put together.[40]

Over the next decade, Australian met coal exports are projected to increase to the point where the emissions generated through their use overtake domestic emissions. By 2030, in order for Australia to achieve its 26-28% Paris target domestic emissions would have to fall by some 92MtCO_2-e a year to 441MtCO_2-e.[41] Industry department figures suggest that total coal exports could rise by more than 50% to nearly 650mt.[42] If met coal's share of total exports remained unchanged, by 2030 they will be around 303mt, compared with 188mt today.[43] The coal being exported by Australia for steel production alone would generate 758MtCO_2-e offshore annually -- 73% more greenhouse than all our domestic emissions combined by 2030.[44] The increased met coal exports alone would erase the benefit of Australia achieving its Paris emissions target more than 3 times over.[45] In short, Australia can't keep feeding the world's dirtiest steel production and claim to be part of a globally credible response to climate change.

An ultimate phasing down of met coal exports by Australia inevitably involves economic costs, but the consequences would not be nearly as dire as many assume and can be mitigated. The most obvious benefits generated from met coal are export income, taxes and royalties, employment, and the spending of wages and salaries by people employed by the coal industry. Because of its much higher price relative to thermal coal, met coal generates a higher proportion of these benefits. Yet in spite of a 50% increase in the volume of met coal being exported, the economic contribution of the industry in Australia has shrunk dramatically.[46] According to the Office of the Chief Economist, the value of met coal exports shrank from $36.8 billion in 2008-09 to $19.5b in 2015-16.[47] At its peak, met coal accounted for 13% of Australia's total exports – in 2015-16 it fell to 6.3%.[48] Royalties generated from met coal production are in decline, most noticeably in Queensland, a state where coking coal accounts for 73% of production and more than 80% of the value of coal exported. Whereas coal royalties were worth over $3 billion dollars the Queensland government is now projecting coal royalties between 2017-2020 to be about a third lower, notwithstanding the recent spike in met coal prices.[49] As the industry employs fewer people, regional economies are getting less benefit from the spending of salaries paid from the coal industry.

The value of met coal has diminished further still when the growth in the overall economy is taken into account. Since the peak in the value of met coal exports in 2008-9, the economy has grown by 16.5%, more than 1.3 million jobs have been added, federal government revenue has increased by 40%.[50] In Queensland, state government revenue has risen by 50% while coal's proportional contribution through royalties is on track to fall by over 50%.[51] Today, the Office of the Chief Economist is forecasting the value of met coal exports at $24.3b in 2019-20, around 1.35% of GDP based on Treasury's projections, compared with 2.65% of GDP in 2008-09. Met coal's contribution to GDP will soon be half as significant as it was.[52] It's becoming more apparent that ever-increasing export volumes do not necessarily mean increased economic importance. Meanwhile, the economy is showing it can diversify and grow in spite of coal's shrinking coal's economic value. Even taking the recent spike in met coal prices (a spike that the government's forecasters expect to be temporary[53]) into account, other sectors of the economy have already added over 6 times the value of met coal exports in the past 7 years.[54] The corollary of met coal's shrinking

Hay Point Coal Terminal in Queensland

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economic value is that the economic losses associated with a withdrawing from met coal are also shrinking.

A withdrawal from met coal exports by Australia is something that couldn't happen overnight. The economic transition and impacts would necessarily be gradual. Along with a moratorium on new mines, Australia could put into place a 7-10 year phase-down timetable to rein in production over a number of years. Well prior to the 2030 timetable to achieve the emissions commitment made in Paris, Australia would exit both the thermal and met coal trade. Contracts could be honoured in the short-medium term; steel mills (both here and abroad) would have time to prepare. There would be time for government to work with communities to manage the regional economic adjustment. Australia should learn from its experience with the thermal coal industry, where the failure of the Federal Government to anticipate or accept the decline of thermal coal has resulted in negative impacts for coal communities. The Turnbull Government has an opportunity to avoid such an outcome for communities currently reliant on the metallurgical coal industry by developing a transition plan for the decline of metallurgical coal and a shift to cleaner steel production right now.

The income, employment, tax and royalty contribution of met coal would decline gradually, and be replaced (as it is being already) by growth in other sectors of the economy. An orderly transition out of met coal would not in and of itself transform the global steel industry. China produces nearly 90% of its own met coal, so the potential environmental impact is limited, as is the potential for economic shock.[55] Nonetheless, it would put upward pressure on blast-furnace production costs, help steer investment towards cleaner alternatives, and set an example for others nations.

If met coal is withdrawn, and BF/BOF production becomes less competitive, it doesn't necessarily spell doom for Australia's iron ore exports. After all, increased market share for EAFs means increased demand for DRI—and iron ore is its main ingredient. If overall demand for steel globally grows as projected, only dominated by DRI/EAF capacity, Australia's iron ore exports should continue to prosper. Similarly, a withdrawal from met coal may boost Australia's beleaguered domestic steel industry. Australia has helped to cause the dire troubles now faced by its steel industry by providing the cheap raw ingredients underpinning the global glut in Chinese steel. Australia's coal-friendly policies have come back to bite its own steel industry. It's also undermined opportunities to value add through domestic DRI production. Australia has plentiful supplies of iron ore and natural gas – we should be a world leader in DRI, but backing BF/BOF production abroad helped to price Australia out of a competitive position. Withdrawing from met coal helps to increase the viability of DRI/EAF route production here in Australia. That should help us meet more domestic steel demand with the more than 2 million tonnes of scrap steel we're currently sending abroad each year.[56]

In weighing whether to wind down met coal exports Australia should avoid counting opportunity costs that are based in wishful thinking, not reality. Rosy estimates of met coal and iron ore demand underpin government policy and corporate planning, and assume that BF/BOF steel production will increase its market share, not just dominate.[57] Aurizon, for example, is assuming that BF/BOF production will jump by 236% in India and become the dominant form of steel production by 2025.[58] BHP has said it doesn't expect the improving competitiveness of EAFs to adversely impact on iron ore demand until at least 2030.[59] To the extent that a slowdown is anticipated in Chinese demand, Australia's coal industry is banking on India in particular to pick up the slack.[60] There are increasing signs, however, that these assumptions are off-beam and already being overtaken by events. Chinese demand for steel is levelling off and looks set to contract.[61] A range of analysts are warning of big falls in Chinese iron ore demand. Some are even predicting China will become a net exporter of met coal by 2025, eventually exporting 90m tonnes per annum.[62] One reason is China's rapid transition from a production based economy to a less resource-intensive consumption and services-based economy. But increased scrap availability and recycling is the other big driver. As McKinsey & Co puts it, 'The scrap wave is coming'.[63]

Goldman Sachs recently suggested that 'by 2040, China's iron ore demand may contract by 50 percent as steel consumption drops and more scrap gets used with greater recycling'.[64] Citigroup says it expects global demand for iron ore to fall by 60mt by 2025, and that in China rising scrap availability will cut into iron ore demand.'[65] The competitiveness of EAFs in China is rapidly improving as the electricity system becomes ever larger and more reliable, and as scrap becomes more available and affordable. The price of scrap steel has been cut in half in China in the last year as it's become more abundant. According to Bloomberg Intelligence it is now more profitable to produce steel in China in an electric arc furnace than it is to do so in a basic oxygen furnace.[66] Morningstar says 'as scrap supply in China rises, the (scrap) price should decline further, providing an incentive for steel producers to switch to the electric-arc furnaces.'[67] Meanwhile, in response to global alarm about the glut of Chinese steel on the international market, the Chinese government is imposing reductions on local production.[68]

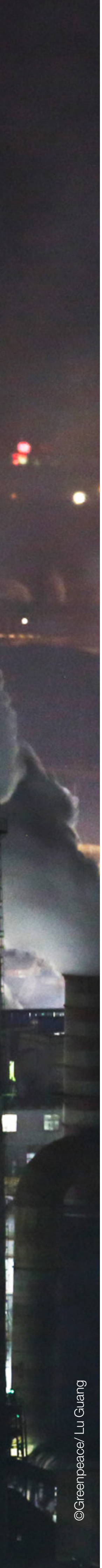
Open Cut Coal Mine in Australia

All things considered, the presumption that China will keep driving a 'super cycle' of demand for iron ore and coal looks flimsy. As Morningstar recently said, 'we project China's domestic scrap supply to more than double by 2025, feeding greater electric arc furnace production and displacing iron ore and met coal demand. In total, falling steel demand and rising scrap availability will reduce China's iron ore demand by 150 million tonnes over the next 10 years... Lower Chinese steel consumption and rising EAF substitution drive our below-consensus demand outlook for iron ore and met coal.'[69] This all suggests that much of what our met coal and iron ore industries are banking on could be illusory. The opportunities Australia is seeking to fulfil in China and looking to manufacture in places like India may not be realistic.

Whether or not the global community forces us to confront it, Australia must not continue to disown its met coal exports, and their growing contribution to climate change. The 'but it's for steel' mantra used to excuse ever expanding met coal exports has been an effective shield from scrutiny, but it's hard to see how it can continue to work in the face of spiralling emissions from steelmaking. In truth, coal is not essential to steelmaking – only to the dirtiest type of steelmaking. By supplying vast quantities of cheap iron ore and met coal, Australia has spent the past 15 years helping to lock in the worst CO_2 outcome in steelmaking, and helping to hinder progress to cleaner alternatives. If it wants to be a credible part of a global response to climate change, Australia cannot do the same thing all over again. Instead it should phase down all its coal exports – including met coal.

Transitioning to cleaner steel production

Steel cities in China's Hebei Province



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Recommendations

Australia is in a unique position to lead sustainable global change in the steel industry. In the short term, the Federal Government should begin to position Australia for a transition away from met coal. This would involve:

- An end to government financial assistance for the coal industry, including subsidies and concessional loans for coal-related infrastructure projects;
- Structural adjustment and government incentive packages to assist workers in a Just Transition away from coal;
- Government programs to encourage new forms of economic opportunities in coal communities;
- A cessation of government support for the promotion of coal exports from Australia via Austrade;
- A re-direction of steel-related diplomatic/trade initiatives and research collaborations to focus on coal-free steel production;
- New incentives for the development of domestic steel production using DRI, EAFs and other clean steel technologies;
- Place a moratorium on new coal mines and coal mine expansions.

Glossary

BF/BOF: blast furnace/basic oxygen furnace

EAF: electric arc furnace

DRI: direct reduced iron

met coal: metallurgical coal (also sometimes referred to as coking coal)

mt: million tonnes

$MtCO_2$-e: metric tons of carbon dioxide equivalent

References

1 The 390mt of coal exported in 2015-16 by Australia included 188 million tonnes of met coal, according to figures from the federal Industry Department See: Resources and Energy Quarterly – March 2017, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p. 50, 60. <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/Resource-and-Energy-Resources-Quarterly-March-2017.pdf>

2 Minerals Council of Australia, 'Coal Hard Facts', Undated (2nd Edition), p.34 Accessed 17 March 2017 <http://www.minerals.org.au/file_upload/files/publications/Coal_Hard_Facts_2nd_Edition_FINAL.pdf>

3 For historical data on Australian coal exports in the 1980s and 1990s see: The Productivity Commission, 'The Australian Black Coal Industry, Inquiry Report No 1 1998 (Volume 2: Appendices)', 1998, p.C9 < http://www.pc.gov.au/inquiries/completed/black-coal/report/coal2.pdf> For contemporary export figures,

4 In 1997 Australia exported around 150mt of iron ore; in 2016-17 the Office of the Chief Economist forecasts exports of 888.1mt. See: Resources and Energy Quarterly – March 2017, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p. 41. <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/Resource-and-Energy-Resources-Quarterly-March-2017.pdf>; See also: Australia's Coal and Iron ore exports 2001 to 2011, 2012, Competitiveness & Advocacy Branch Department of Foreign Affairs and Trade, p.4 < https://dfat.gov.au/about-us/publications/Documents/australias-coal-and-iron-ore-exports-2001-to-2011.pdf > See also 'Table 28 -- Resources and Energy Quarterly — Historic data', Office of the Chief Economist, Department of Industry and Science, Accessed 5 May 2017 < https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Resources-and-energy-quarterly.aspx>

5 Imports of Australian met coal have risen by 81.9mt since 2001 from 106.1mt to 188mt in 2015-16. Over the same period, global coking coal exports have increased from around 180mt to 315mt. See: Coal in India - 2015, 2015, Office of the Chief Economist, Department of Industry and Science. p. 80 <https://www.industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/Coal-in-India.pdf> See also: Resources and Energy Quarterly – March 2017, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p. 47. <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/Resource-and-Energy-Resources-Quarterly-March-2017.pdf>See also: Analyst Presentation: Industry Background: Coking Coal – Overview, 2002, BHP Mitsubishi Alliance, p.11,15 <http://www.bhpbilliton.com/~/media/bhp/documents/investors/reports/2002/bmaanalystpresentation2002.pdf?la=en>

6 Re: China, see: 'China's metallurgical coal import sources (mt)', S&P Global Platts, 2013, Accessed 17 March 2017 <http://www.platts.com/news-feature/2013/metals/mongolian-steel/steel-imports> http://www.platts.com/news-feature/2013/metals/mongolian-steel/steel-imports ; Re India, see: Government of India – Ministry of Coal, 'Production & Supplies', Accessed 17 March 2017 <http://coal.nic.in/content/production-supplies> and Coal in India - 2015, 2015, Office of the Chief Economist, Department of Industry and Science. p. 80 <https://www.industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/Coal-in-India.pdf>

7 'Reflections from the Seventies', Four Corners--ABC TV, 2014, < http://www.abc.net.au/4corners/stories/s350401.htm>

8 Steel accounts for 6.7% of global emissions. See: Steel's Contribution to a Low Carbon Future and Climate Resilient Societies, 2015, World Steel Association, p. 4 <http://www.worldsteel.org/publications/position-papers/steel-s-contribution-to-a-low-carbon-future.html> See also: Intergovernmental Panel on Climate Change, 'IPCC Fourth Assessment Report: Climate Change 2007; Working Group III: Mitigation of Climate Change - 7.4.1 Iron and steel'. Accessed 17 March 2017 <https://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch7s7-4-1.html>

9 2.5t CO2 per tonne of coal is a conservative assumption. The National Greenhouse Accounts Factors assumes 2.7t of CO2 per tonne. However, this allows for some variation in met coal quality, and the loss of a small amount of carbon that remains in steel. See: "Table 1: Fuel Combustion Emission Factors", National Greenhouse Accounts Factors, 2014, Australian Government Department of the Environment, p.11. <http://www.environment.gov.au/system/files/resources/b24f8db4-e55a-4deb-a0b3- 32cf763a5dab/files/national-greenhouse-accounts-factors-dec-2014.pdf >

10 Australian coking coal exports generate 470mt of emissions relative to national emissions of 535.7mt at the end of 2015-16 -- or 88%. See: Australian Government – Department of the Environment, 'Quarterly Update of Australia's National Greenhouse Gas Inventory: December 2015 -- Australia's National Greenhouse Accounts', 2016, p.3 Accessed 17 March 2017 <https://www.environment.gov.au/system/files/resources/7c0b18b4-f230-444a-8ccd-162c8545daa6/files/nggi-quarterly-update-dec-2015.pdf> p.3 See also: Resources and Energy Quarterly – March 2017, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p. 50. <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/Resource-and-Energy-Resources-Quarterly-March-2017.pdf>

11 Australia's 188mt of met coal exports in 2015-16 is 59.7% of the global trade. See Resources and Energy Quarterly – March 2017, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p. 47. <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/Resource-and-Energy-Resources-Quarterly-March-2017.pdf>

12 The size of the global seaborne met coal trade increased from 197mt in 1997 to 315 in 2015-16, an increase of 117mt. Over the same period, Australia's met coal exports increased by 104mt from 83.7mt to 188mt. See: Resources and Energy Quarterly – March 2017, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p. 47. <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/Resource-and-Energy-Resources-Quarterly-March-2017.pdf> and Overview of Value Adding to Queensland Minerals, Department of State Development & the Department of Mines and Energy, Queensland Government, 1999, p.8 <http://www.aph.gov.au/parliamentary_business/committees/house_of_representatives_committees?url=isr/valadd2/subs/sub43attach1.pdf>

13 Brazilian iron ore exports increased from 156.9mt in the year 2000 to 317mt in 2016. See: 'Brazil – Mining', Nations Encyclopedia, Accessed 17 March 2017 <http://www.nationsencyclopedia.com/Americas/Brazil-MINING.html> and 'Iron Ore Giants to Increase Supplies by 200m tonnes through 2020', Australian Financial Review, 2016, Accessed 17/3/17 <http://www.afr.com/business/mining/iron-ore/iron-ore-giants-to-increase-supplies-by-200m-tonnes-through-2020-20160926-grp2ls>

14 The ratio of scrap steel use to crude steel production in China is 1/5th of the EU, and 1/7th of the US. See: World Steel Recycling in Figures 2010-2014 -- Steel Scrap: a Raw Material for Steelmaking, Bureau of International Recycling – Ferrous Division, 2015 p. 15,17,18. <http://bdsv.org/downloads/weltstatistik_2010_2014.pdf>

15 As a percentage of TWh produced world-wide: Natural Gas 21.6%; Hydro 16.4%; other renewables 6.3% -- combined total 44.3%. See: Key World Energy Statistics, International Energy Agency, 2016, p.24 <https://www.iea.org/publications/freepublications/publication/KeyWorld2016.pdf>

16 See: Steel Statistical Yearbook 2016, 2016, World Steel Association p.16 <http://www.worldsteel.org/steel-by-topic/statistics/steel-statistical-yearbook-.html>

17 2015 World Direct Reduction Statistics, 2016, Midrex Technologies p.2 <http://www.midrex.com/assets/user/news/MidrexStatsBook2015.pdf>

18 Williams, Keith. 'Metallurgical Coal: Is There A Future?', Seeking Alpha, 2016. Accessed 17 March 2017 <http://seekingalpha.com/article/3785906-metallurgical-coal-future?page=2> Stahlseite Industriefotografie, 'Burns Harbor: The last integrated steel mill built in the United States'2012 Accessed on 17 March 2017, < http://www.steel-photo.org/2012/10/08/burns-harbor-the-last-integrated-steel-mill-built-in-the-united-states/>

19 See Steel Statistical Yearbook 2016, 2016, World Steel Association p.15 <http://www.worldsteel.org/steel-by-topic/statistics/steel-statistical-yearbook-.html>

20 Installed coal fired power capacity in China has risen from 223GW in 2000 to over 900 GW in 2016. See: Myllyvirta, Lauri. 'China keeps building coal plants despite new overcapacity policy', Greenpeace Energy Desk, 2016, Accessed 17 March 2017 <http://energydesk.greenpeace.org/2016/07/13/china-keeps-building-coal-plants-despite-new-overcapacity-policy/> Chinese crude steel production has increased from 127mt in 2000 to 803mt in 2015. See: Worldsteel.org statistical year books at <http://www.worldsteel.org/statistics/statistics-archive/yearbook-archive.html>

21 See: International Energy Agency, 'Emissions Reduction through Upgrade of Coal-Fired Power Plants -- Learning from Chinese Experience', 2014, Accessed 17 March 2017 <https://www.iea.org/publications/freepublications/publication/PartnerCountrySeriesEmissionsReductionthroughUpgradeofCoalFiredPowerPlants.pdf> Campbell, Richard J., 'China and the United States—A Comparison of Green Energy Programs and Policies', Congressional Research Service, 2014, p.1 Accessed 17 March 2017 <https://fas.org/sgp/crs/row/R41748.pdf> Ito, Osamu. 'Emissions from coal fired power Generation', Presentation to Workshop on IEA High Efficiency, Low Emissions Coal Technology Roadmap, Energy Technology Policy Division -- International Energy Agency, 2011, p.3 Accessed 17 March 2017, <https://www.iea.org/media/workshops/2011/cea/Ito.pdf> Ives, Mike. 'China's drive to clean up its coal power, one plant at a time', New Scientist, 2016 Accessed 17 March 2017 <https://www.newscientist.com/article/2101780-chinas-drive-to-clean-up-its-coal-power-one-plant-at-a-time/> Bradsher, Keith. 'China Outpaces U.S. in Cleaner Coal-Fired Plants', New York Times, 2009 Accessed 17 March 2017 <http://www.nytimes.com/2009/05/11/world/asia/11coal.html?_r=1&>

22 International Energy Agency, 'World electricity demand since 1990, with related total and regional CO2 emissions' Accessed 10 November 2016 <https://www.iea.org/newsroom/graphics/world-electricity-demand-since-1990-with-related-total-and-regional-co2-emissio.html>

23 Net Exports in 2015 – China 98.4mt, Japan 34.9mt, Russia 25.3mt, Ukraine 16.9mt, Brazil 10.5mt, South Korea 9.5mt. See: World Steel in Figures 2016, 2016, Worldsteel.org, p.27 < http://www.worldsteel.org/media-centre/press-releases/2016/world-Steel-in-figures-2016-is-available-online.html>

24 See Steel Statistical Yearbook 2016, 2016, World Steel Association p.2 <http://www.worldsteel.org/steel-by-topic/statistics/steel-statistical-yearbook-.html>

25 Total crude steel production rose from 843.3mt in 2000 to 1.62mt in 2015. BOF-based production accounted for 708.8mt of the increase, EAFs just 122mt of the increase. See Steel Statistical Yearbook 2001, 20001, World Steel Association p.34. <http://www.worldsteel.org/steel-by-topic/statistics/steel-statistical-yearbook-.html> and Steel Statistical Yearbook 2016, 2016, World Steel Association p.18 <http://www.worldsteel.org/steel-by-topic/statistics/steel-statistical-yearbook-.html>

26 Steel Statistical Yearbook 2015, 2015, World Steel Association p.21 <http://www.worldsteel.org/steel-by-topic/statistics/steel-statistical-yearbook-.html>

27 According to the Global CCS Institute, 'On average, emissions are around 2t CO2 per tonne of steel produced using the blast furnace route', whereas 'The DRI-EAF process is a lower emitter of CO2 (400-500kg CO2 per ton of steel)'. They also note that BOF route emissions are much higher in China and India: 'China and India: 3.1 to 3.8 t CO2/t steel'. Of the 773mt increase in annual steel production since 2000, the BF/BOF route accounted for around 90%. Assuming 3t CO2 per tonne of steel for the additional 708mt of BOF-route production, and .5t CO2 per tonne of steel via additional EAF production, additional CO2 emissions are well over 2 billion tonnes per annum. See: : 'CCS for iron and steel production', ULCOS (republished by the Global Carbon Capture and Storage Institute, 2013, Accessed 17 March 2017 <https://www. globalccsinstitute. authors/

dennisvanpuyvelde/2013/08/23/ccs-iron-and-steel-production>and 'Steel', Centre for Science and Environment—India, Accessed 17 March 2017 <http://www.cseindia.org/userfiles/39-56%20Steel(1).pdf> See also: Global Carbon Capture and Storage Institute, '3.3.2. Capture for the Iron & Steel industry', Accessed 17 March 2017 <https://hub.globalccsinstitute.com/publications/ideal-portfolio-ccs-projects-and-rationale-supporting-projects-report/332-capture-iron> Laplace Conseil - Metal and Mining strategy consultant, 'Impacts of energy market developments on the steel industry', Presentation at 74th Session of the OECD Steel Committee, 2013 p.9 Accessed 18 March 2017 <http://www.oecd.org/sti/ind/Item%209.%20Laplace%20-%20Steel%20Energy.pdf>, See also Nova, Gianluigi, 'Energy and environment Tenova latest technologies', Tenova, 2011, p.10 Accessed 18 March 2017 < http://www.metec-estad2015.com/files/openingsessions/1120_Gianluigi_Nova.pdf>

28 Steel Statistical Yearbook 2015, 2015, World Steel Association p.20, 24 <http://www.worldsteel.org/steel-by-topic/statistics/steel-statistical-yearbook-.html>

29 Clayton, Travis. 'The Iron and Steel Industry in China: Part I', University of Texas at Austin, 2014, Accessed 17 March 2017 <https://sites.utexas.edu/mecc/2014/05/01/the-iron-and-steel-industry-in-china-part-i/> <http://www.bhpbilliton.com/~/media/bhp/documents/investors/reports/2006/060516colinoliviericoaltransbrazilmay2006.pdf>

30 See: <http://www.worldsteel.org/steel-by-topic/statistics/steel-statistical-yearbook-.html>

31 The size of the global seaborne met coal trade has increased from 170mt in 2000 to 315mt in 2015-16, an increase f 145mt. See Resources and Energy Quarterly – March 2017, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p. 47. <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/Resource-and-Energy-Resources-Quarterly-March-2017.pdf> and BHP Pty Ltd, Submission to the Productivity Commission Inquiry into The Black Coal Industry, 1999, p.2 Accessed 17 March 2017 <http://www.pc.gov.au/inquiries/completed/black-coal/submissions/bhp_coal_pty_ltd_/sub030.pdf>

32 Gielen, D & Van Dri, T, 'CO2 Reduction Strategies in the Basic Metals Industry: A Systems Approach', Accessed 17 March 2017 <https://www.ecn.nl/fileadmin/ecn/units/bs/matter/1999/dg06.pdf>

33 'Global steel output to scale 2,000-mt by 2030, led by India', Business Standard, 2015, Accessed 17 March 2017 <http://www.business-standard.com/article/pti-stories/global-steel-output-to-scale-2-000-mt-by-2030-led-by-india-115041900150_1.html>

34 Rajesh, Roy. 'India Steel Minister: Government Aims to Treble Steel Production Capacity by 2025', The Wall Street Journal, 2015, <https://www.wsj.com/articles/india-steel-minister-government-aims-to-treble-steel-production-capacity-by-2025-1433172500>

35 See Steel Statistical Yearbook 2016, 2016, World Steel Association p16. Accessed 17 March 2017 < http://www.worldsteel.org/>

36 Assuming BF/BOF route accounts for 90% of the 400mt of additional crude steel production added by 2030. Also assumes that India accounts for 60% of the new capacity, and that BF/BOF route emissions there would range between 2.8-3.8t CO2 per tonne of crude steel, in keeping with a range of estimates, and that the remaining capacity averages the 2.0t CO2 per tonne of crude steel average nominated by the UNFCCC. See: 'CCS for iron and steel production', ULCOS (republished by the Global Carbon Capture and Storage Institute, 2013, Accessed 17 March 2017 <https://www.globalccsinstitute.com/insights/authors/dennisvanpuyvelde/2013/08/23/ccs-iron-and-steel-production> and 'Steel', Centre for Science and Environment—India, Accessed 17 March 2017 <http://www.cseindia.org/userfiles/39-56%20Steel(1).pdf>

37 Assuming DRI/EAF route emissions of 0.5-0.7t CO2 per tonne of crude steel vs 2.1-2.5t CO2 per tonne of crude steel in the BF/BOF route. Probably a conservative estimate given the rates for BF/BOF in India and China are much higher. See: Laplace Conseil - Metal and Mining strategy consultant, 'Impacts of energy market developments on the steel industry', Presentation at 74th Session of the OECD Steel Committee, 2013 p.9 Accessed 18 March 2017 <http://www.oecd.org/sti/ind/Item%209.%20Laplace%20-%20Steel%20Energy.pdf> Nova, Gianluigi, 'Energy and environment Tenova latest technologies', Tenova, 2011, p.10 Accessed 18 March 2017 < http://www.metec-estad2015.com/files/openingsessions/1120_Gianluigi_Nova.pdf> and 'CCS for iron and steel production', ULCOS (republished by the Global Carbon Capture and Storage Institute, 2013, Accessed 17 March 2017 <https://www.globalccsinstitute.com/insights/authors/dennisvanpuyvelde/2013/08/23/ccs-iron-and-steel-production>

38 World Steel Association, 'Sustainable Steel -- At the core of a green economy', 2012, P.13, 18. Accessed 17 March 2017 <https://www.worldsteel.org/publications/bookshop/product-details.~Sustainable-steel--At-the-core-of-a-green-economy~PRODUCT~sustainability2012~.html>

39 According to work published by the Global CCS Institute, 'On average, emissions are around 2t CO2 per tonne of steel produced using the blast furnace route' whereas 'The DRI-EAF process is a lower emitter of CO2 (400-500kg CO2 per ton of steel)' – a difference of over 75% on average. They also note that BOF route emissions are much higher in China and India: 'China and India: 3.1 to 3.8 t CO2/t steel'. So, the difference is likely even greater in those countries. See: 'CCS for iron and steel production', ULCOS (republished by the Global Carbon Capture and Storage Institute, 2013, Accessed 17 March 2017 <https://www.globalccsinstitute.com/insights/authors/dennisvanpuyvelde/2013/08/23/ccs-iron-and-steel-production> and 'Steel', Centre for Science and Environment—India, Accessed 17 March 2017 <http://www.cseindia.org/userfiles/39-56%20Steel(1).pdf> See: Global Carbon Capture and Storage Institute, '3.3.2. Capture for the Iron & Steel industry', Accessed 17 March 2017 <https://hub.globalccsinstitute.com/publications/ideal-portfolio-ccs-projects-and-rationale-supporting-projects-report/332-capture-iron> Laplace Conseil - Metal and Mining strategy consultant, 'Impacts of energy market developments on the steel industry', Presentation at 74th Session of the OECD Steel Committee, 2013 p.9 Accessed 18 March 2017 <http://www.oecd.org/sti/ind/Item%209.%20Laplace%20-%20Steel%20Energy.pdf> See also Nova, Gianluigi, 'Energy and environment Tenova latest technologies', Tenova, 2011, p.10 Accessed 18 March 2017 < http://www.metec-estad2015.com/files/openingsessions/1120_Gianluigi_Nova.pdf>

40 World Coal Association, 'Coal market & pricing', Accessed 17 March 2017 <http://www.worldcoal.org/coal/coal-market-pricing >

41 For Australia to achieve a 28% reduction by 2030, emissions would have to fall from 612mt in 2005 to 441mt in 2030. See: 'Australia's 2030 Emissions Reduction Target - Factsheet', 2016, Commonwealth of Australia p.5 Accessed 17 March 2017 < https://www.environment.gov.au/system/files/resources/f52d7587-8103-49a3-aeb6-651885fa6095/files/summary-australias-2030-emissions-reduction-target.pdf>

42 See: Australian Energy Projections to 2049-50, 2014, Bureau of Resources and Energy Economics. p.42-3, <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/aep/aep-2014-v2.pdf> See also: Promoting Australian Prosperity and Sustaining the Boom with Export Infrastructure, Bureau of Resources and Energy Economics, 2014, p.8,9. <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/other/export_infrastructure_supplemental.pdf>

43 At present, met coal accounts for 188mt of 390mt of coaal exports, or around 48%. If that ratio remained the same and Australia's coal exports grow as projected met coal exports would rise by around 115mt by 2030. Total met coal exports would be 303mt. See Australian Energy Projections to 2049-50, 2014, Bureau of Resources and Energy Economics. p.42-3, <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/aep/aep-2014-v2.pdf> See also Resources and Energy Quarterly – March 2017, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p. 50. <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/Resource-and-Energy-Resources-Quarterly-March-2017.pdf>

44 If total met coal exports rise to 305.5mt, emissions exported in met coal would be just over 763mt. If Australia achieves a 28% reduction by 2030 domestic emissions will be 441mt. Met coal exports alone would account for 322mt (or 73%) more emissions than the entire domestic Australian economy. This assumes 2.5 tonnes of CO2 per tonne of coal exported. See: 'Australia's 2030 Emissions Reduction Target - Factsheet', 2016, Commonwealth of Australia p.5 Accessed 17 March 2017 < https://www.environment.gov.au/system/files/resources/f52d7587-8103-49a3-aeb6-651885fa6095/files/summary-australias-2030-emissions-reduction-target.pdf>See also: "Table 1: Fuel Combustion Emission Factors", National Greenhouse Accounts Factors, 2014, Australian Government Department of the Environment, p.11. <http://www.environment.gov.au/system/files/resources/b24f8db4-e55a-4deb-a0b3- 32cf763a5dab/files/national-greenhouse-accounts-factors-dec-2014.pdf >

45 In 2015-16 Australia's 188mt of met coal exports generated some 470mt of CO2 abroad. If Australia added another 115mt as projected by 2030, the emissions exported annually in met coal would rise to 758mt per annum – a 288mt increase. This would be 3.1 times the 92mt per annum domestic emissions reduction required for Australia to achieve a 28% reduction in line with its Paris target. See: Australian Energy Projections to 2049-50, 2014, Bureau of Resources and Energy Economics. p.42-3, <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/aep/aep-2014-v2.pdf> Resources and Energy Quarterly – March 2017, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p. 50. <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/Resource-and-Energy-Resources-Quarterly-March-2017.pdf> and 'Australia's 2030 Emissions Reduction Target - Factsheet', 2016, Commonwealth of Australia p.5 Accessed 17 March 2017 < https://www.environment.gov.au/system/files/resources/f52d7587-8103-49a3-aeb6-651885fa6095/files/summary-australias-2030-emissions-reduction-target.pdf>

46 In 2008-09 Australia exported 125mt of met coal, compared with an estimated 188mt in 2015-16 and a forecast 191mt in 2016-17. See Resources and Energy Quarterly – March 2017, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p. 49, 50. <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/Resource-and-Energy-Resources-Quarterly-March-2017.pdf> and Australia's Coal and Iron ore exports 2001 to 2011, 2012, Competitiveness & Advocacy Branch Department of Foreign Affairs and Trade, p.4 < https://dfat.gov.au/about-us/publications/Documents/australias-coal-and-iron-ore-exports-2001-to-2011.pdf>

47 See: Australian Bureau of Statistics, 'Production and Trade – Minerals, Oil and Gas', 1301.0 - Year Book Australia, 2012, , Accessed 18 March 2017 <http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1301.0~2012~Main%20Features~Production%20and%20trade%20~%20minerals,%20oil%20and%20gas~153> and Resources and Energy Quarterly – September 2016, 2016, Office of the Chief Economist, Department of Industry, Innovation and Science, p.43 <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/REQ-September-2016.pdf>

48 Based on $36.8b in 2008-09 out of total goods and services exports of $283.5b; vs an estimated $19.79b out of an estimated $312.3b in 2015-16. See: Department of Foreign Affairs and Trade , 'Australia's trade and Economic Indicators', Trade and Investment Statistics – Trade Time Series Data, Accessed 18 March 2017 <http://dfat.gov.au/trade/resources/trade-statistics/Pages/trade-time-series-data.aspx> and <https://dfat.gov.au/trade/resources/trade-statistics/Documents/australias-trade-and-economic-indicators-historical.xls> See also Department of Foreign Affairs and Trade , 'Australia's trade in goods and services 2015-16, Trade and Investment Statistics – Trade Time Series Data, Accessed 18 March 2017 <http://dfat.gov.au/about-us/publications/trade-investment/australias-trade-in-goods-and-services/Pages/australias-trade-in-goods-and-services-2015-16.aspx> and 'Table 24 (1 & 2) -- Resources and Energy Quarterly — Historic data', Office of the Chief Economist, Department of Industry and Science, Accessed 18 March 2017 < https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Resources-and-energy-quarterly.aspx> Australian Bureau of

Statistics, '5204.0 - Australian System of National Accounts, 2015-16, 2016, Accessed 18 March 2017 <http://www.abs.gov.au/AUSSTATS/ABS@.NSF/7d12b0f6763c78caca257061001cc588/bfef5c43f53f8d2bca257213001d23c9!OpenDocument>

49 See: Queensland Government, 'Coal industry review statistical tables--Total value of exports per year', Accessed 18 March 2017 < https://data.qld.gov.au/dataset/coal-industry-review-statistical-tables/resource/fccfc461-7673-4d4b-a03f-321314501edb> and <https://data.qld.gov.au/dataset/coal-industry-review-statistical-tables/resource/6a4b92fc-b277-40d2-af6c-26ea14cad6f6> In 2009 at the height of the boom, the Queensland government received $3.03bn out of revenue of $37.2bn -- 8.2%. Budget Paper 2 - Budget Strategy and Outlook 2009-10, Queensland Government, 2009, p. 87, 113 <https://www.treasury.qld.gov.au/publications-resources/state-budget/2009-10/budget-papers/documents/bp2-2009-10.pdf> See also Queensland Budget 2016-17 – Mid Year Fiscal and Economic Review, Queensland Treasury, 2016, p.26 <https://www.treasury.qld.gov.au/publications-resources/mid-year-review/mid-year-review-2016-17.pdf>

50 GDP increased from $1.39b in 2008-09 to $1.617b in 2015-6, or around $227b. See: Resources and Energy Quarterly – December 2016, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p.107 <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/REQ-December-2016.pdf> See also: Department of Foreign Affairs and Trade , 'Australia's trade and Economic Indicators', Trade and Investment Statistics – Trade Time Series Data, Accessed 18 March 2017 <http://dfat.gov.au/trade/resources/trade-statistics/Pages/trade-time-series-data.aspx> and <https://dfat.gov.au/trade/resources/trade-statistics/Documents/australias-trade-and-economic-indicators-historical.xls> According to the ABS, the total number of employed persons in March 2017 is 12,059,600. In February 2009 it was 10,745,400 See: Australian Bureau of Statistics, '6202.0 - Labour Force, Australia, March 2017, 2017, Accessed 5 May 2017 <http://www.abs.gov.au/ausstats/abs@.nsf/mf/6202.0> See also: Australian Bureau of Statistics, '6202.0.55.001 - Labour Force, Australia, Spreadsheets, Jan 2009, 2009, Accessed 18 March 2017 <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6202.0.55.001Jan%202009?OpenDocument > Federal government revenue for 2016-17 is $411b compared with $293b in 2008-09. See: 'Statement 4 – Revenue' Budget Papers, Department of the Treasury, 2016, <http://www.budget.gov.au/2016-17/content/bp1/html/bp1_bs4-02.htm> 'Statement 4 – Revenue', Budget Papers, Department of the Treasury, 2008 <http://www.budget.gov.au/2015-16/content/bp1/html/bp1_bs4-06_online.htm>

51 In 2009 at the height of the boom, the Queensland government received $3.03bn out of revenue of $37.2bn -- 8.2%. Budget Paper 2 - Budget Strategy and Outlook 2009-10, Queensland Government, 2009, p. 87, 113 <https://www.treasury.qld.gov.au/publications-resources/state-budget/2009-10/budget-papers/documents/bp2-2009-10.pdf>
In 2017-18 the Queensland Government expects some $2 billion from coal royalties out of total revenue of $55.63b – 3.6%. See: Queensland Budget 2016-17 – Mid Year Fiscal and Economic Review, Queensland Treasury, 2016, p.26, 39 <https://www.treasury.qld.gov.au/publications-resources/mid-year-review/mid-year-review-2016-17.pdf>

52 In 2008-09, met coal exports were valued at $36.8b – or 2.64% of a GDP of $1.39b in 2008-09; By 2019-20, Treasury's annual growth projections suggest that GDP will be over $1.8b, while the Office of the Chief Economist is forecasting met coal exports to be worth $24.3b, or just 1.35% of GDP. See: Resources and Energy Quarterly – December 2016, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p.40 <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/REQ-December-2016.pdf> See also: See also 'Table 2 – Major Economic Parameters', Pre-election Economic and Fiscal Outlook 2016, Statement by the Treasurer and Minister for Finance and Deregulation, 2016, <http://www.treasury.gov.au/PublicationsAndMedia/Publications/2016/PEFO-2016/HTML/Economic-outlook> See also: Department of Foreign Affairs and Trade , 'Australia's trade and Economic Indicators', Trade and Investment Statistics – Trade Time Series Data, Accessed 18 March 2017 <http://dfat.gov.au/trade/resources/trade-statistics/Pages/trade-time-series-data.aspx> and <https://dfat.gov.au/trade/resources/trade-statistics/Documents/australias-trade-and-economic-indicators-historical.xls> See also Australian Bureau of Statistics, 'Production and Trade – Minerals, Oil and Gas', 1301.0 - Year Book Australia, 2012, Accessed 18 March 2017 <http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1301.0~2012~Main%20Features~Production%20and%20trade%20~%20minerals,%20oil%20and%20gas~153> and Resources and Energy Quarterly – December 2016, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p.40 <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/REQ-December-2016.pdf>;

53 The Office of the Chief Economist forecasts the value of met coal exports to rise from $20.1b in 2015-16 to $36.6b in 2016-17, before falling to $24.3b in 2019-20. See Resources and Energy Quarterly – March 2017, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p. 50. <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/Resource-and-Energy-Resources-Quarterly-March-2017.pdf>

54 GDP increased from $1.39b in 2008-09 to $1.62b in 2015-6, or around $230b. That is roughly 6 times the $36.6b forecast value of met coal exports in 2016-17. See: . See Resources and Energy Quarterly – March 2017, 2017, Office of the Chief Economist, Department of Industry, Innovation and Science. p. 50. <https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/Resource-and-Energy-Resources-Quarterly-March-2017.pdf> See also: Department of Foreign Affairs and Trade , 'Australia's trade and Economic Indicators', Trade and Investment Statistics – Trade Time Series Data, Accessed 18 March 2017 <http://dfat.gov.au/trade/resources/trade-statistics/Pages/trade-time-series-data.aspx> and <https://dfat.gov.au/trade/resources/trade-statistics/Documents/australias-trade-and-economic-indicators-historical.xls>

55 Coaltrans Conferences, 'Coaltrans China - Who has the advantage in supplying China's coking coal demand?' Accessed 18 March 2017 <http://www.coaltrans.com/articles/3336459/coaltrans-china-who-has-the-advantage-in-supplying-chinas-coking-coal-demand.html> Garcia, L. F. Sarcinelli and De Fari, Carlos, 'World Market for Metallurgical Coal', Presentation by Sage Consultoria Tecnica Ltda, 2013, p. 8 Accessed 18 March 2017 <http://www.abmbrasil.com.br/cim/download/Luiz%20fernando.pdf> Holloway, James et al. 'China's Steel Industry', RBA Bulletin December, 2010, p.22 Accessed 18 March 2017 < http://www.rba.gov.au/publications/bulletin/2010/dec/pdf/bu-1210-3.pdf>

56 World Steel Recycling in Figures 2010-2014 -- Steel Scrap: a Raw Material for Steelmaking, Bureau of International Recycling – Ferrous Division, 2015 p. 25. <http://bdsv.org/downloads/weltstatistik_2010_2014.pdf> See also Australian Bureau of Statistics, '4602.0.55.005 - Waste Account, Australia, Experimental Estimates, 2013, 2013, Accessed 18 March 2017 <http://www.abs.gov.au/ausstats/abs@.nsf/Products/4602.0.55.005~2013~Main+Features~Australia's+International+Trade+in+Waste?OpenDocument>

57 See: Hyvonen, Markus and Langcak, Sean. 'India's Steel Industry', RBA Bulletin, 2012 <http://www.rba.gov.au/publications/bulletin/2012/mar/pdf/bu-0312-4.pdf > See also Delivering for the Long Haul -- FY2015 Sustainability Report, 2015, Aurizon, p.18 <http://www.aurizon.com.au/sustainability/overview> and Ng, Jasmine. 'Goldman Takes Ax to Iron Ore Outlook as Industry Hibernates' Bloomberg, 2015 Accessed 17 March 2017 <https://www.bloomberg.com/news/articles/2015-12-17/goldman-takes-ax-to-iron-ore-forecasts-as-industry-to-hibernate> See also: Coal in India - 2015, 2015, Office of the Chief Economist, Department of Industry and Science. <https://www.industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/Coal-in-India.pdf>

58 See: Delivering for the Long Haul -- FY2015 Sustainability Report, 2015, Aurizon, p.18 <http://www.aurizon.com.au/sustainability/overview> See also Wilson, Alex. 'Coal prices to remain high: Rio Tinto', The Australian, 2010 <http://www.theaustralian.com.au/archive/business/coal-prices-to-remain-high-rio-tinto/news-story/8f6e954fce8f3085e94e279251c5a7b0>

59 Stringer, David. 'BHP, Rio: Iron-ore's next big threat looms in China's junkyards', Sydney Morning Herald, 2016 Accessed 17 March 2017 < http://www.smh.com.au/business/mining-and-resources/bhp-rio-ironores-next-big-threat-looms-in-chinas-junkyards-20160413-go54s9.html>

60 Minerals Council of Australia, 'Coal Hard Facts', Undated (2nd Edition), p.34 Accessed 17 March 2017 <http://www.minerals.org.au/file_upload/files/publications/Coal_Hard_Facts_2nd_Edition_FINAL.pdf> Whitehaven Coal Limited, 'Presentation at the 2016 Global Metals and Mining Conference', 2016, p.6 Accessed 18 March 2017 <http://www.whitehavencoal.com.au/investors/docs/bmo-global-metals-and-mining-conference-presentation.pdf> Latimer, Cole. 'Australia slated to become largest coal exporter', Australian Mining, 2015, Accessed 18 March 2018 <https://www.australianmining.com.au/news/%e2%80%8baustralia-slated-to-become-largest-coal-exporter/>

61 Duck, Stephen. 'Will China become a net exporter of metallurgical coal?', CRU Commodity Pricing and Research, 2016 <http://www.crugroup.com/about-cru/cruinsight/Met_Coal_Will_China_Become_a_Net_exporter>

62 Duck, Stephen. 'Will China become a net exporter of metallurgical coal?', CRU Commodity Pricing and Research, 2016 <http://www.crugroup.com/about-cru/cruinsight/Met_Coal_Will_China_Become_a_Net_exporter>

63 Stringer, David. 'China's Swelling Junkyards Are Readying Iron Ore's Next Threat', Bloomberg News, 2016 Accessed 18 March 2017 < https://www.bloomberg.com/news/articles/2016-04-12/china-s-swelling-junkyards-are-readying-iron-ore-s-next-threat>

64 Ng, Jasmine. 'Goldman Takes Ax to Iron Ore Outlook as Industry Hibernates' Bloomberg, 2015 Accessed 17 March 2017 <https://www.bloomberg.com/news/articles/2015-12-17/goldman-takes-ax-to-iron-ore-forecasts-as-industry-to-hibernate>

65 Serapio, Manolo. 'Citigroup cuts long-term iron ore forecast to $55 as demand shrinks' Reuters News, 2015, Accessed 18 March 2017 < http://in.reuters.com/article/ironore-citigroup-forecast-idINKBN0OC0B520150527>

66 Stringer, David. 'BHP, Rio: Iron-ore's next big threat looms in China's junkyards', Sydney Morning Herald, 2016 Accessed 17 March 2017 < http://www.smh.com.au/business/mining-and-resources/bhp-rio-ironores-next-big-threat-looms-in-chinas-junkyards-20160413-go54s9.html>

67 Stringer, David. 'China's Swelling Junkyards Are Readying Iron Ore's Next Threat', Bloomberg News, 2016 Accessed 18 March 2017 < https://www.bloomberg.com/news/articles/2016-04-12/china-s-swelling-junkyards-are-readying-iron-ore-s-next-threat>

68 'China Pledges Steel, Coal Capacity Cuts in Supply-Side Reforms', Bloomberg News, 2016 Accessed 18 March 2017 <https://www.bloomberg.com/news/articles/2016-01-24/china-pledges-steel-coal-capacity-cuts-in-supply-side-reforms>

69 Morningstar Equity Analysts, 'Miners Will Suffer as China's Scrap Metal Supply Rises, 2016, Accessed 17 March 2017 <http://www.morningstar.co.uk/uk/news/148978/miners-will-suffer-as-chinas-scrap-metal-supply-rises.aspx>

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