

TOWN AND COUNTRY PLANNING ACT 1990

**Application by West Cumbria Mining Ltd for:
Development of a new underground metallurgical coal mine and associated
development at Former Marchon Site, Pow Beck Valley and area from Marchon Site to
St Bees Coast**

Planning Inspectorate Reference: APP/H0900/V/21/3271069

Local Planning Authority Reference: 4/17/9007

Date Inquiry Commences: 7th September 2021

REBUTTAL PROOF OF EVIDENCE

of

Stuart Haszeldine OBE FRSE C.Geol

**Professor of Carbon Capture and Storage
School of GeoSciences
University of Edinburgh**

31 August 2021

CONTENTS

1. Introduction.....	4
2. Coal Quality and Marketability	4
3. Beneficiation / Coal Processing.....	9
4. Carbon Capture and Sequestration	10

Appendices to SLACC/SH/3

		Pages
Appendix R1	Letter: Materials Processing Institute to South Lakes Action on Climate Change, 31 August 2021	14
Appendix R2	S&P Global Platts, Specifications Guide: Metallurgical Coal (Apr. 2020)	19
Appendix R3	Javelin Global Commodities (UK) Ltd, Financial Statements for the Year Ended 31 December 2019 (31 July 2020)	37
Appendix R4	SSAB, 18 Aug 2021, The world's first fossil free steel ready for delivery, SAAB Website. https://www.ssab.co.uk/news/2021/08/the-worlds-first-fossilfree-steel-ready-for-delivery	82
Appendix R5	Noor, D. 21 Aug 2021, <i>Behold, carbon free steel now exists</i> , Gizmodo Website. https://gizmodo.com/ behold-carbon-free-steel-now-exists-1847524486	85
Appendix R6	Echterhof, T., Review on the Use of Alternative Carbon Sources in EAF Steelmaking. Metals 2021, 11, 222 https://doi.org/10.3390/met11020222	88

1 INTRODUCTION

- 1.1. In this rebuttal evidence I respond to certain aspects of the proof of evidence and appendices of Jim Truman [WCM/JT/1 & WCM/JT/2] and of Mark Kirkbride [WCM/MAK/1 & WCM/MAK/2]. This rebuttal evidence should be read together with my proof of evidence [SLACC/SH/1].
- 1.2. I provide this evidence as an independent expert, to whom no payment has been made. This proof of evidence is true to the best of my knowledge, and the professional interpretation and opinions are mine, founded on the factual evidence which has been gathered in connection with this appeal.

2 COAL QUALITY & MARKETABILITY

- 2.1. Mr Truman states in his proof at paragraph 5.1 that West Cumbria Mining coal is comparable to US High-Vol A quality and is expected to be highly marketable in the European market.
- 2.2. First, I note that, it is clear from the Wood Mackenzie Report (“**WM Report**”) which appears as the appendix to his Proof of Evidence and on which many of the findings in Mr Truman’s evidence are based (WCM/JT/1 Para 2.2), that Mr Truman and his colleagues have simply been provided with the specifications of the product which WCM claims will be achieved. (WCM/JT/2 para 2.6) WCM has still provided no data on the Run of Mine coal. As set out in my proof of evidence, it is not clear what processing is proposed or whether it would be achievable to produce coal of the specifications claimed, given the high sulphur content of the targeted seams. This was previously addressed in my proof at SLACC/SH/1, in particular at paras 3.6-3.7, 6.3-6.4, 7.1-7.5.
- 2.3. Mr Truman is not entirely clear whether he actually considers the WCM coal to be High Vol A, in accordance with WCM’s statement of case (SOC para 112). As above he states that it is “comparable” to US High Vol A coals (WCM/JT/1 para 5.1) but he then goes on to say simply that the WCM product “presents a high-volatile coking coal.”

- 2.4. Mr Truman then says (WCM/JT/1 para 5.4) that “West Cumbria Mining’s coking coal exhibits almost all of the key parameters used to designate HVA quality.” (my emphasis) At WCM/JT/2, table 2.1 and 2.2 of the WM Report set out key parameters for metallurgical coal. It may be noted that the (claimed) WCM coal specifications are outside the range given in Table 2.2 for of both HVA and HVB coal in respect of multiple parameters.

Sulphur

- 2.5. The WM Report indicates that HVA coal has a maximum sulphur content of 1.3% and that HVB coal has a maximum sulphur content of 1.4%. (WCM/JT/2 page 22, table 2.2) The inclusion of sulphur content in the marketable qualification of metallurgical coal is, itself, noteworthy. In original submissions to Cumbria County Council, WCM continually described their coal in terms of its physical coking properties. The WM Report now recognises that the sulphur content is one of the important criteria which a metallurgical coal must meet.
- 2.6. However, WCM’s evidence indicates that the coal produced by the mine would range up to 1.6% sulphur content. [WCM/MAK/1 para 7.11; WCM/MAK/2 p 71] Even at the annual average value of 1.4% sulphur, which they claim that 80% of the coal will meet [Id], this is not within the WM Report specification for HVA coal. As I have previously set out, in fact the evidence indicates that 1.1% sulphur is the upper limit for marketable HV metallurgical coals. It is notable in this regard that the WM Report indicates that “sulphur in coke should not exceed 0.7%” (WCM/JT/2 Table 2.1, p 21). In fact, the Edinburgh Report indicated that this might range up to 0.9% but in either case, the figure would not be achievable with more than a small percentage of WCM coal in the coking coal blend. This is implicitly recognised by the WM Report, which indicates that the “addressable market” for WCM coal is only “between 5-6 Mtpa over the 2021-2049 period” including the UK, the EU and Turkey. (WCM/JT/2 para 2.32) whereas, they say, total coal demand will be roughly 10 times this figure (WCM/JT/2 para 1.35; figure 1.8).
- 2.7. Mr Truman argues that the typical sulphur specification for steel mills in the UK region are < 1.0%, but that by accepting a decreased selling price penalty for exceeding that sulphur mark the coals would be marketable. (JT/1 para 5.4) Mr Truman states that

“cokemakers should be able to maintain an acceptable overall sulphur level in their blend” and by implication, that this could be done by increasing the amount of Australian coal, which can have sulphur contents ranging between 0.5% and 0.6%. Mr Truman states that he estimates the penalty due to high sulphur content would be US\$7.7/t. (WCM/JT/1 para 7.5)

- 2.8. Mr Truman, however, does not present any evidence that UK or European cokemakers would actually be willing or able to pay such a penalty to use WCM coal.
- 2.9. SLACC have received a letter from the Materials Processing Institute (MPI), providing a short commentary on the WM Report, which is attached as Appendix R1. MPI is a research and innovation centre which provides expertise to the steel industry domestically and internationally. It was founded as the British Iron & Steel Research Association in 1944, having been set up by Sir Winston Churchill’s wartime government to equip the British steel industry for post-war reconstruction.
- 2.10. The MPI comments on Mr Truman’s JT/2 should be read in full, but I note that, in relation to the sulphur content of WCM’s coal, MPI indicates its view that the WCM level of sulphur is high and that many cokemaking operations are “constrained on S [sulphur] input”. (Appendix R1, page 16, para 4) MPI explain that “UK carboniferous coals generally have higher total sulphur contents than their US equivalents. This led to them being phased out of use as prime metallurgical coals in the early 1980’s as high sulphur emissions from coke plants in the UK, in the form of H₂S, caused acid rain formation that severely damaged the environment in Scandinavia and northern Europe. Consequently, the Environment Agency imposed restrictions on the use of high sulphur coals for cokemaking.” (Id.)
- 2.11. MPI cites the example of British Steel’s integrated steelworks at Scunthorpe, where it says that a limiting value of 0.75% db sulphur is applied. Such regulatory constraints (which MPI notes are similar across Europe) (Id.) mean that even with a significant lower costs of purchase benefit, cokemakers may simply be unable to use the coal.

- 2.12. MPI also notes, when reviewing the WM's statements at para 2.12 of its report (Appendix R1, page 18, para 1) that the analysis in the report is "superficial" indicating MPI's view that "Cost and price penalties are not the issue with S. Environmental legislation is the driver. High S coals are prohibited."
- 2.13. The regulatory limits noted by MPI accord with specifications for internationally traded coal (Edinburgh report Fig 3, Fig 5, Fig 7, Fig 8). In the same way that CO₂ emissions are not controlled by costs in the market but are regulated by environmental policies which have driven significant decarbonisation; so the sulphur content is not controlled by cost, but is regulated to control acid sulphur emissions and eliminate environmental damage.
- 2.14. I also append the full version of the S&P Global Platts Specification Guide for Global Metallurgical Coal (Appendix R2), sections of which are excerpted in the Edinburgh Report which was an appendix to my main proof. As will be noted, all of the seaborne hard coking coals have a quoted specification on sulphur of 1% or less. (Appendix R2, pages 21-22). One can then consider the section on "Penalties and Premia for Seaborne HCC". (Appendix R2, page 25) It may be noted that (1) penalties apply to any coal with sulphur content higher than 0.7%, and (2) the highest sulphur content for which a penalty is quoted is the range 1.06-1.25% sulphur.
- 2.15. In fact, 1.25% sulphur was the maximum sulphur content for metallurgical coal within the planning condition proposed by Cumbria County Council in March 2019. Of course, that proposal (prior to amendment by WCM in spring 2020) also involved the production of "middlings coal" by WCM with sulphur above 2% for non-metallurgical purposes. WCM has now indicated it will no longer produce such middlings coal (but I also understand that WCM indicates that a condition to limit the maximum or average sulphur specification of the coal is unnecessary).
- 2.16. 1.25% sulphur content seems to be an upper limit on internationally-marketable coal, and as I set out in my main proof of evidence, in fact, almost all sources quote upper limits of 1.0 or 1.1%. (See para 5.3 and following table).

- 2.17. It is not at all clear from this evidence that the WCM would actually be marketable as metallurgical coal at a sulphur content of up to 1.6%, or the claimed annual average figure of 1.4%. MPI's evidence indicates that steel mills in the EU and the UK would face regulatory limits that could prevent its use. To the extent that the coal is marketable, it therefore seems the most likely destination for much of the coal would be outside the UK/EU, where looser regulatory constraints on sulphur may apply.
- 2.18. In my main Proof of Evidence, I established that west Cumbria coals are amongst the highest sulphur content in the UK, where the Main Band coal proposed to be extracted by WCM has a range of sulphur values from about 1.2% to 2.95%, with an average around 1.9%. And the Bannock Band coal has a range from 2.0% to 3.45% with an average of 2.6% (Edinburgh report Fig 19, Fig 20).
- 2.19. As set out below in Section 3, it is not at all clear that the sulphur limits WCM indicates it will meet are actually achievable based on the quality of the Run of Mine coal. But in any case, the evidence indicates that – even if WCM does achieve its claimed specifications – the coal is likely to have a sulphur content which makes it unsuitable for the UK and EU steel industries.

Other coal specifications

- 2.20. I note that the WCM coal is no longer described as “premium” metallurgical coal in the WM evidence, whereas in prior submissions to Cumbria County Council [e.g. para 112 of WCM Statement of Case], this adjective was often applied. This suggests that initial over-optimism is gradually being decreased by the reality of the measured properties of the coal.
- 2.21. MPI's letter notes that a number of other aspects of the WCM coal specifications – in addition to sulphur - are not in accordance with the specifications for HVA and HVB coal – for instance CSR, for which MPI states the value is “too low for the HVA and HVB classification.” (Appendix R1, page 16, para 5) MPI also indicates that the coal specifications are incomplete and “therefore do not indicate [the WCM coal] qualifies as HVA or would be a suitable marketable alternative to prime quality US HVA coals.” (Appendix R1, page 16, para 7)
- 2.22. When considering the analysis in the WM Report in relation to the costs of WCM coal

in a coking blend, MPI also notes that the analysis focuses solely on price but that “There is no guarantee that any of the blends containing WCM will produce coke of the same quality as, or better than, the benchmark blend. So, value-in-use, which is far more important to the ironmaking process overall, has not been considered.” (Appendix R1, page 18, final para) If the blend with WCM exceeds regulatory emissions limits on sulphur or produces an inferior product, it is very unlikely that UK and EU steelmakers would choose to use WCM coal.

Javelin Global Commodities

- 2.23. WCM also relies partially on evidence that there is a market for the coal by citing Javelin Global Commodities (UK) Ltd and appending a letter indicating that Javelin has entered into an “exclusive marketing ... arrangement” whereby it will market 100% of WCM’s production. [WCM/MAK/1 at para 11.9; WCM/MAK/2 p 79]
- 2.24. At Appendix R3 are the Financial Statements for Javelin Global Commodities (UK) Ltd for the year ended 31 December 2019 (the most recent available), obtained from Companies House. These indicate that Javelin markets coal globally in many regions, with their largest market being in Asia. (Appendix R3, page 67)

3 BENEFICIATION / COAL PROCESSING

- 3.1. I noted in my main proof that it was not clear whether the coal handling and processing plant (CHPP) processes and conditions proposed by WCM now are the same as the CHPP proposed at the time of the October 2020 Committee meeting (SLACC/SH/1 para 7.5)
- 3.2. Some minor further details have now been provided at WCM/MAK/1 paras 7.1 – 7.15.
- 3.3. It appears from the letter from Parnaby Cyclones exhibited to Mr Kirkbride’s proof [WCM/MAK/2, page 71] that WCM received a “finalised plant design and flow diagram” on 7 May 2020. However, I understand that this has never been disclosed, including in response to requests for details of the Coal Handling and Processing Plant by SLACC’s solicitors on 10 June 2021, 5 July 2021, and 24 July 2021.
- 3.4. It is not possible on the information provided to consider whether the specifications of

the product coal are achievable (as discussed above) or to consider the potential environmental impacts that could arise from the coal handling, processing, and paste and backfill process. I addressed these potential impacts in my main proof, and I have seen nothing further to indicate that they have been considered. (See SLACC/SH/1 Section 8).

4 CARBON CAPTURE AND SEQUESTRATION

- 4.1. Carbon Capture and Storage is one of my main topics of research and development expertise, and during the past 17 years I have developed close professional partnerships with academic researchers, research to solve problems for commercial developers, and commentary and advice on policy directions and regulation for BEIS (UK Government Department of Energy). I can therefore provide relevant and authoritative opinion on current and future directions.
- 4.2. WM discuss the possibility of CCS being fitted onto Blast Furnace plant which produces primary iron as a feed to steel making. Their assertion appears to be that CCS has not been introduced successfully because it is expensive and technically difficult [WCM/JT-2 Para 1.51-1.59]. But WM also comment that costs are expected to decline. They argue that some unspecified type of advances and cost reductions in CCS technology will support a large increase in its application to steel making in the future (para 1.58). That depends on steel makers being expected to continue investing in CCS which will support the continuation of BF-BOF steel production in Europe (para 1.59).
- 4.3. WM cite the Arcelor Mittal process recently published, in which part of iron making CO₂ emissions are converted to alcohol (WCM/JT/2 Para 1.52), which is then sold off-site. It is a mistake to define this as CCS. By contrast this is clearly Utilisation of waste CO₂, to make a chemical which can be profitably sold. That does not store the carbon emitted from the iron and steel making site, but merely moves it off the steel making site. Investigations to decarbonise existing Blast Furnace processes are progressing only slowly and it remains uncertain that significant progress will be made before 2050 Net Zero.

- 4.4. It is clear that the decarbonisation of UK industry is being driven by climate policies, such as the UK Government's interim climate target of 78% decrease of CO₂e emissions against a 1990 baseline. [CD 8.21] Similar policies in the EU mean that the gradual and protracted pathway to decarbonise current iron and steel making processes using efficiency improvements and CCS proposed in Wood Mackenzie's Base Case Scenario (JT2/2 Para 1.62) is very unlikely to be accepted by Government policy in the UK or EU.
- 4.5. I concur with (Nilsson SLACC/LN/1) that an increasing amount of steel in Europe will be supplied by recycled steel, purified in electric arc furnaces (EAF). In addition the industrial scale operation of hydrogen based Direct Reduced Iron (H-DRI) has recently been achieved by SSAB/LKAB and Vattenfall in August 2021¹, with the intention of full industrial scale by late 2026. This is a significant achievement, providing confidence for other developers to follow.²
- 4.6. MPI's letter (Appendix R1, page 14, next to last para) states that coking coal or even high carbon coal is not necessary for Electric Arc Furnaces – so new steel can be made with different sources of carbon³. MPI also indicates that Europe is accelerating a switch to low carbon EAF that it considers that the WM evidence is “at odds with data from other relevant sources that show much more EAF production”. (Appendix R1, page 15, first two paragraphs)
- 4.7. Wood Mackenzie's AET2.0 scenario (JT2/2 para 1.72- 1.78), with a fall in emissions from the global steel industry of 47% by 2040, does refer to increased use of EAF and DRI technology. This scenario is said to require 30% of residual carbon emissions from residual steel production methods to be captured and stored (around 325Mtpa). (WCM/JT/2 para 1.74) However, this scenario is not considered in Mr Truman's proof, and the % carbon emissions captured by CCS or CCUS is insufficient to meet the climate policy imperatives, or the pace of change required.
- 4.8. A clear pathway is now available commercially to eliminate the need for Blast

¹ Appendix R4 (SH/3 page 82); SSAB, 18 Aug 2021, *The world's first fossil free steel ready for delivery*, SAAB Website. <https://www.ssab.co.uk/news/2021/08/the-worlds-first-fossilfree-steel-ready-for-delivery>.

² Appendix R5 (SH/3 page 85); Noor, D. 21 Aug 2021 Behold, carbon free steel now exists. Gizmodo Website <https://gizmodo.com/behold-carbon-free-steel-now-exists-1847524486>.

³ Appendix R6 (SH/3 page 88); Echterhof, T. Review on the Use of Alternative Carbon Sources in EAF Steelmaking. Metals 2021, 11, 222. <https://doi.org/10.3390/met11020222>.

Furnaces and eliminate the need to use metallurgical coal as a reagent to make coke, and as a heat source. This will eliminate any UK industrial iron facilities which cannot decarbonise by other methods. The UK market for metallurgical coal will disappear. I also concur that a method of solving emissions is to change the industrial process, to emit less CO₂,

- 4.9. Similar transitions are occurring in steel making worldwide. The major steel making corporations of the world are individually making pledges of significant decarbonisation before 2030, and net zero operations by 2050. Decarbonisation could in principle be firstly by Carbon Capture and Storage, but the Global CCS Institute shows no plans for major projects (likely due to the technical difficulty and expense and incomplete nature of CO₂ capture from iron and steel making).
- 4.10. The alternative route of major process change to use hydrogen as a reagent with no requirement for CCS appears to be favoured by many of the world's largest steel companies. This topic is covered more comprehensively in Lars Nilsson's evidence.
- 4.11. While CCS and CCUS are important technologies, there is no evidence that they will be the preferred or primary route for decarbonisation of steel making, particularly in Europe.

Declaration

The evidence which I have prepared and provide for this appeal reference APP/H0900/V/21/3271069 in this proof of evidence is true, and I confirm that the opinions expressed are my true opinions.

Appendices to SLACC/SH/3

		Pages
Appendix R1	Letter: Materials Processing Institute to South Lakes Action on Climate Change, 31 August 2021	14
Appendix R2	S&P Global Platts, Specifications Guide: Metallurgical Coal (Apr. 2020)	19
Appendix R3	Javelin Global Commodities (UK) Ltd, Financial Statements for the Year Ended 31 December 2019 (31 July 2020)	37
Appendix R4	SSAB, 18 Aug 2021, The world's first fossil free steel ready for delivery, SAAB Website. https://www.ssab.co.uk/news/2021/08/the-worlds-first-fossilfree-steel-ready-for-delivery	82
Appendix R5	Noor, D. 21 Aug 2021, <i>Behold, carbon free steel now exists</i> , Gizmodo Website. https://gizmodo.com/ behold-carbon-free-steel-now-exists-1847524486	85
Appendix R6	Echterhof, T., Review on the Use of Alternative Carbon Sources in EAF Steelmaking. Metals 2021, 11, 222 https://doi.org/10.3390/met11020222	88

Maggie Mason
South Lakes Action on Climate Change
maggiem.mason@gmail.com

31 August 2021

Critique of Wood Mackenzie Report on Steel and Metallurgical Coal

Dear Ms Mason,

Materials Processing Institute (the Institute) has been requested to review and critique sections of a report prepared by Wood Mackenzie on behalf of West Cumbria Mining (WCM), dated 10th August 2021 and titled; Steel and Metallurgical Coal – Expert Report, ref WCM/JT/2.

Materials Processing Institute

The Materials Processing Institute is a research and innovation centre serving global steel and materials organisations that work in advanced materials, industrial decarbonisation, the circular economy, and digital technologies. The Institute offers research, consultancy and training services from its campus in Teesside, delivering expert advice and new technology to the steel industry internationally.

The Institute has served as the UK's national steel innovation centre since 1944 having been set up by Sir Winston Churchill's wartime government just before D-Day to equip the British steel industry for post-war reconstruction. It celebrated its 75th anniversary in 2019.

Through collaboration with its customers, the Institute provides a range of technology and R&D based services and consultancy. It also has pilot and demonstration facilities.

Works with: steel, metals and alloys, chemical processes, aerospace and defence, energy, mining and quarrying, construction, rail, transport, and infrastructure, offshore, subsea, and nuclear.

The Institute's views and expert opinions are recorded against the JT/2 paragraph numbers, as follows:

- 1.18 *"Coal used in EAFs does not require coking properties, therefore thermal coal can be used."* - Clarification: The EAF requirement is for high calorific value (CV) carbon to provide additional heat for the process, therefore crushed/powdered high rank coal or anthracite, or other forms of carbon can be used. Thermal coal can be used provided it meets all the other process quality requirements. Metallurgical coal is not required, per se.
- 1.19 *"EAF production accounted for 27% of global steel production in 2020"* – Yes, although it accounted for 42% in EU28 (i.e. incl. UK), and 48% when including Turkey.

- 1.29 Process route assumptions for steel production to 2049 seems to be at odds with data from other relevant sources that show much more EAF production.
- 1.33 See comment on 1.29: Europe is accelerating the switch to EAF and current BF's will be replaced as they reach end of life.
- 1.34 *"The use of high-quality iron ore (high Fe and low gangue contents) can reduce the coke requirements of the blast furnace, allowing lower fuel rates and emissions."* - Iron ore quality is declining globally, so this assumption is optimistic. By 2049, metallurgical coal demand is expected to be much lower than indicated in the chart.
- 1.35 We disagree with the report's assumptions about coal demand. Note that Sweden is "hidden" in rest of Europe, so their move to zero coal use is not expressed.
- 1.39 See comment on 1.29
- 2.5 *"Low-volatile coals provide most of the coke strength, while high-volatile coals allow good blending and porosity to the coke."* - Not quite. LV coals in the blend contribute to higher coke strength. HV coals improve blend fluidity and aid interaction between the coals during carbonisation. What is "good porosity"?

Table 2.1: The definitions here are very poor and show a lack of understanding of the parameters being measured and what they mean. For example, CSN is Crucible Swelling Number, which shows the extent to which a coal is likely to expand on the application of heat. It is not a reactivity measurement and some hard coking coals from Australia, Canada and Southern Africa can have CSN values in the range 5-7. Also, vitrinite reflectance is the true measure of rank, not just an indicator, as volatile matter content is.

Table 2.2: Quality of the data in general

It is unacceptable to quote the values for the Proximate Analysis as plain percentage figures. The basis on which they are calculated must be given, i.e.:

1. as received (%ar) – sample tested still contains moisture, as only equilibrated to the lab conditions.
2. dry basis (%db) – values corrected for moisture content, after removal, by drying in nitrogen at 100 °C.
3. dry ash free basis (%daf) – values corrected for moisture and ash content.

The values in the table appear to be dry basis.

It is unacceptable to steelmakers to quote "<1.5 % sulphur". An actual figure or range must be given.

CSR is quoted, but the Coke Reactivity Index, CRI, must also be given as this parameter is just as important and is used to assess coal and coke quality.

Table 2.2: Comments on WCM coal quality:

Ash – Low, desirable for a good quality coal. On a par with US HVA coals.

Volatile Matter – Typical of a HVA coal.

Sulphur – High, undesirable for a good quality coal. UK carboniferous coals generally have higher total sulphur contents than their US equivalents. This led to them being phased out of use as prime metallurgical coals in the early 1980's as high sulphur emissions from coke plants in the UK, in the form of H_2S , caused acid rain formation that severely damaged the environment in Scandinavia and northern Europe. Consequently, the Environment Agency imposed restrictions on the use of high sulphur coals for cokemaking. At Scunthorpe, for example, the cokemaking operations are constrained on S input, meaning the use of an individual coal in the blend with total S above 0.8 %db is not permitted (a limiting value of 0.75 %db is used to ensure compliance). Cost penalties for S content are irrelevant in this situation. To meet S emissions limits for coke plants across Europe, similar legislative constraints are applied, and again cost is not the issue.

CSR – Poor and needs to be quoted with the corresponding CRI value from the test. The value quoted is too low for the HVA and HVB classification. We know that the CRI value will also be too high for both HVA and HVB.

Ash chemistry – Incomplete for a full appraisal. The values quoted are acceptable, especially considering the low ash content of the coal. The calcium oxide value is high and it would be necessary for the magnesium oxide value to be provided to help give a meaningful appraisal of alkaline earth element content. Alkali metals are not quoted. These are important as their presence in the coke has severe adverse impact on Blast furnace (BF) operations and also carry a cost penalty.

Summary of comments on Table 2.2: The WCM Coal specifications, as stated, are incomplete and therefore do not indicate it qualifies as HVA or would be a suitable marketable alternative to prime quality US HVA coals.

2.7 *“The high fluidity allows the coal to liquefy and act as a binder in a coke blend.”* - Incorrect: Coals do not fully liquefy in the true sense of the word and HV coals do not form a binder for the coke matrix. Rather, the fluidity exhibited by HV coals aids the interaction of individual coals in the blend and promotes the formation of the liquid crystal phase responsible for the formation of the crystalline coke structure by stabilising free radicals formed by bond breaking as the coals decompose on heating. By comparison, a LV coal will have a limited degree and temperature range of fluidity because of more rapid cross-linking and bond forming during carbonisation.

“The high VM content lowers the yield of solid coke, but provides output gas and liquids, which are captured or processed on site for sale or recycled at the mill.” - Not really relevant: Yes, coke yield is reduced, but by-product yield is a consequence of overall blend VM content. Hence, a target blend VM is used to control coke yield, along with coke oven charging density and moisture content.



- 2.8 *“High Vol A (i.e. high fluidity, low ash and good ash chemistry) are occasionally priced at parity, or even at a premium, to the benchmark Australian LV HCC on an FOB basis.”* - Incorrect: The benchmark coal against which all other prices are derived will always be the most expensive on the market as it is the coal capable of forming high quality metallurgical coke. We have never seen the price of a HVA coal exceed the benchmark.
- 2.9 *“Other high-volatile coals in several countries (notably from the Kuzbass and South Yakutiya basins in the Central and Far East of Russia) mostly have lower fluidity and higher ash content,”* - These are inferior quality HV coals and are not classified as HVA, so if WCM want to show their coal is better than these, why have they not included their data in the assessment?
- 2.10 *“West Cumbria Mining’s coking coal exhibits almost all of the key parameters used to designate HVA quality.”* - Key statement. But not **ALL** the HVA parameters, just some. Which you could say of any coal if you cherry pick the right parameters you want.

“Fluidity: At 30,000 ddpm, the maximum fluidity is comparable to US HVA coking coals. This is one of the most important quality characteristics of the West Cumbria product. High-volatile coals with strong fluidity in the blend allows steel companies greater flexibility to select other coals to include. It allows the coals to blend better into a good coke. The most common equipment used to measure fluidity are only able to measure up to 30,000 ddpm (i.e. it is at the top of the range).” - True to an extent. Coal interaction in a blend during carbonisation is extremely complex and single coal fluidity alone does not confer good coking properties or improved performance in carbonisation. Also, some instruments can measure beyond 30,000 ddpm, but US specs and the ASTM test only specify 30,000 as the maximum and do not recognise values above this, even if they can be measured.

“CSN: The CSN is the most basic test to determine a coal’s ability to form coke.” - Incorrect: It just demonstrates the coal’s ability to swell. Some high CSN coals do not make high quality coke and some low CSN coals do.

“Sulphur: At <1.5%, the sulphur content is higher than the normal spec at coke plants. Using this coal in the blend would require adjusting the overall sulphur content by including other coals with lower sulphur levels. Since most European mills use a portion of Australian coals, which average 0.5% to 0.6% sulphur in the blend, we believe these mills can use West Cumbria Coal in their blends.” - Quite an assumption, especially if the S content is at 1.5 %db, rather than this vague, “less-than” figure, and sulphur constraints operate as per Scunthorpe steel works.

“Phosphorus: The phosphorus is extremely low, which will help offset the higher sulphur in marketing and price discussions.” - Incorrect: The 2 issues are not linked. S is mainly environmental. P is metal chemistry. S is total in the whole coal, P is only in the mineral matter and not such an issue, as mineral matter content is low.

“Ash chemistry: This is acceptable, with low elements which contribute to coke degradation (Fe₂O₃, and CaO,).” Partially correct: Other elements in the ash are just as, if not more, important and are not reported (Na, K, Mg).

- 2.12 *"We view the expected sulphur content of West Cumbria Mining's product at <1.5% to be marketable to European steel mills. We believe the typical sulphur spec for steel mills in the region are <1.0%. Therefore, the company would be required to pay a penalty for exceeding that mark. However, most companies use a significant amount of Australian coal in their blends, which have sulphur contents ranging between 0.5% and 0.6%. So, cokemakers should be able to maintain an acceptable overall sulphur level in their blend to produce good-quality coke. The penalty on sulphur would be somewhat balanced by a premium for having extremely low ash and phosphorus content."* - Superficial: Cost and price penalties are not the issue with S. Environmental legislation is the driver. High S coals are prohibited.

Operating Cost Analysis

Projections to 2029 are very difficult to fully justify as global coal prices have in the past proved very volatile. Supply and demand can be hit by a number of factors that are impossible to predict with any degree of accuracy. So, the hypotheses put forward in this section need to be treated with a degree of scepticism.

- 2.32 Seems to assume business as usual right up to 2049 for the UK and the rest of Europe. Is this justified? We think not.

Figure 2.6 Shows a blip in the usual price range trend due to a political decision made by China. Nothing to do with supply and demand to the rest of the world, or quality. This illustrates the point on pricing projections mentioned above.

- 2.38 The pricing of the WCM product will have no impact whatsoever on the benchmark global price of metallurgical coal.
- 2.39 *"Historically, the maximum discount of the US HVA price to the PLV HCC price has been valued at ~15%, outside of times of serious supply disruption (e.g. Australian cyclones)."* - Serious supply disruption of Australian coals significantly impacts the price and supply of predominantly MV and LV hard coking coals, the major products exported from there. HV prices usually remain fairly consistent.

2.41 to 2.46 Concentrate solely on potential blend price and savings against a standard blend. There is no guarantee that any of the blends containing WCM will produce coke of the same quality as, or better than, the benchmark blend. So, value-in-use, which is far more important to the ironmaking process overall, has not been considered.

Specifications guide

Metallurgical coal

Latest update: April 2020

Definitions of the trading locations for which Platts publishes index and assessments	2
Assessed specifications	2
Seaborne hard coking coal	3
Seaborne PCI coal	6
Penalties and Premia for Seaborne HCC	7
Brand Relativities	8
Semi-Soft Coking Coal	10
Metallurgical Coke	11
Derivatives	13
Domestic Chinese	14
Revision history	17

SEABORNE HARD COKING COAL

Assessment	CODE	Mavg	Wavg	Rolling month	Type	Published	Page	Quality	Quantity	Incoterms	Location	Timing	Payment UOM
Australia													
HCC Peak Downs FOB Australia	HCCGA00	HCCGA03			Assessment	Daily	205	74% CSR, 20.7% VM, 9.5% TM, 10.5% ash, 0.6% sulfur, 0.03% phosphorus, 400 ddmp max fluidity, 8.5 CSN, 71% vitrinite, 1.42% Ro Max, particle size 50 mm max	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight \$/mt
Premium Low Vol HCC FOB Australia	PLVHA00	PLVHA03			Assessment	Daily	205	71% CSR, 21.5% VM, 9.7% TM, 9.3% ash, 0.5% sulfur, 0.045% phosphorus, 500 ddpm max fluidity, 65% vitrinite	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight \$/mt
TSI Premium Hard Coking Coal Australia Export FOB East Coast Port	TS01034	TSMBH03		TSMBV03	Index	Daily	205	71% CSR, 21% VM, 10% TM, 10% ash, 0.45% sulfur, 0.05% phosphorus, 600 ddpm fluidity, 68% vitrinite, 1.35% Rvmax, FSI 8, totdal dilatation 80%, paricle size below 55 mm for at least 90% of the cargo	Min 15,000 mt	FOB	East Coast Port, Australia	Loading 7-60 days forward	L/C at sight \$/mt
Hard Coking Coal FOB Australia	HCCAU00	HCCAU03	HCCAU04		Assessment	Daily	205	62% CSR, 21.5% VM, 10.5% TM, 8% ash, 0.45% sulfur, 0.06% phosphorus, 100 ddpm max fluidity, 52% vitrinite	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight \$/mt
TSI Hard Coking Coal Australia Export FOB East Coast Port	TS01035	TSMBI03			Calculation	Daily	205	62% CSR, 21.5% VM, 10.5% TM, 8% ash, 0.45% sulfur, 0.06% phosphorus, 100 ddpm max fluidity, 52% vitrinite	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight \$/mt
HCC Peak Downs FOB Australia (China Netback)	HCCGD00				Calculation	Daily	205	74% CSR, 20.7% VM, 9.5% TM, 10.5% ash, 0.6% sulfur, 0.03% phosphorus, 400 ddmp max fluidity, 8.5 CSN, 71% vitrinite, 1.42% Ro Max, particle size 50 mm max	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight \$/mt
Prem Low Vol HCC FOB Australia (China Netback)	PLVHD00				Calculation	Daily	205	71% CSR, 21.5% VM, 9.7% TM, 9.3% ash, 0.5% sulfur, 0.045% phosphorus, 500 ddpm max fluidity, 65% vitrinite	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight \$/mt
China													
Hard Coking Coal Peak Downs CFR China	HCCGC00	HCCGC03			Assessment	Daily	205	74% CSR, 20.7% VM, 9.5% TM, 10.5% ash, 0.6% sulfur, 0.03% phosphorus, 400 ddmp max fluidity, 8.5 CSN, 71% vitrinite, 1.42% Ro Max, 50 mm max	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight \$/mt
TSI Prem JM25 Coking Coal China Imports CFR Jingtang Port	TS01044	TSMBR03		TSMBW03	Calculation	Daily	205	71% CSR, 21.5% VM, 9.7% TM, 9.3% ash, 0.5% sulfur, 0.045% phosphorus, 500 ddpm max fluidity, 65% vitrinite	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight \$/mt
Premium Low Vol HCC CFR China	PLVHC00	PLVHC03			Assessment	Daily	205	71% CSR, 21.5% VM, 9.7% TM, 9.3% ash, 0.5% sulfur, 0.045% phosphorus, 500 ddpm max fluidity, 65% vitrinite	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight \$/mt
Hard Coking Coal CFR China	HCCCH00	HCCCH03	HCCCH04		Assessment	Daily	205	62% CSR, 21.5% VM, 10.5% TM, 8% ash, 0.45% sulfur, 0.06% phosphorus, 100 ddpm max fluidity, 52% vitrinite	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight \$/mt
TSI Hard JM25 Coking Coal China Imports CFR Jingtang Port	TS01045	TSMBS03			Calculation	Daily	205	62% CSR, 21.5% VM, 10.5% TM, 8% ash, 0.45% sulfur, 0.06% phosphorus, 100 ddpm max fluidity, 52% vitrinite	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight \$/mt
India													
HCC Peak Downs CFR India	HCCGI00	HCCGI03			Assessment	Daily	205	74% CSR, 20.7% VM, 9.5% TM, 10.5% ash, 0.6% sulfur, 0.03% phosphorus, 400 ddmp max fluidity, 8.5 CSN, 71% vitrinite, 1.42% Ro Max, 50 mm max	Min 10,000 mt	CFR	Paradip, India	Delivered 20-65 days forward	L/C at sight \$/mt
Premium Low Vol HCC CFR India	PLVHI00	PLVHI03			Assessment	Daily	205	71% CSR, 21.5% VM, 9.7% TM, 9.3% ash, 0.5% sulfur, 0.045% phosphorus, 500 ddpm max fluidity, 65% vitrinite	Min 10,000 mt	CFR	Paradip, India	Delivered 20-65 days forward	L/C at sight \$/mt
Hard Coking Coal CFR India	HCCIN00	HCCIN03	HCCIN04		Assessment	Daily	205	62% CSR, 21.5% VM, 10.5% TM, 8% ash, 0.45% sulfur, 0.06% phosphorus, 100 ddpm max fluidity, 52% vitrinite	Min 10,000 mt	CFR	Paradip, India	Delivered 20-65 days forward	L/C at sight \$/mt

SEABORNE HARD COKING COAL

Assessment	CODE	Mavg	Wavg	Rolling month	Type	Published	Page	Quality	Quantity	Incoterms	Location	Timing	Payment UOM
US*													
Low Vol Hard Coking Coal FOB USEC	AAWWR00	AAWWR03			Assessment	Daily	1049	58% CSR, 19.25% VM, 8% TM, 8.25% ash, 0.95% sulfur	Min 10,000 mt	FOB	Hampton Roads, US	Loading 14-60 days forward	L/C at sight \$/mt
High Vol A Coking Coal FOB USEC	AAWWS00	AAWWS03			Assessment	Daily	1049	32.25% VM, 8% TM, 7.5% ash, 0.95% sulfur, 30,000 ddpm max fluidity, 1.05 MMR, 220% dilatation	Min 10,000 mt	FOB	Hampton Roads, US	Loading 14-60 days forward	L/C at sight \$/mt
High Vol B Coking Coal FOB USEC	AAWWT00	AAWWT03			Assessment	Daily	1049	36% VM, 8% TM, 8% ash, 1% sulfur, 25,000 ddpm max fluidity, 0.95 MMR, 160% dilatation	Min 10,000 mt	FOB	Hampton Roads, US	Loading 14-60 days forward	L/C at sight \$/mt
* all relevant specification dry basis													
Europe													
Premium Low Vol HCC CFR NWE	PLVHE00	PLVHE03			Calculation	Daily	205	71% CSR, 21.5% VM, 9.7% TM, 9.3% ash, 0.5% sulfur, 0.045% phosphorus, 500 ddpm max fluidity, 65% vitrinite	Min 10,000 mt	CFR	Rotterdam, Netherlands	Delivered 52-90 days forward	L/C at sight \$/mt

Seaborne Hard Coking Coal

Australia

Price assessments

PLVHA00 - Premium Low Vol HCC FOB Australia

HCCGA00 - Peak Downs Region HCC FOB Australia

Premium Low Vol and Peak Downs® assessments on an FOB Australia basis reflect the spot transactable value at the close of the assessment period on the day of publishing. These assessments are based on FOB Australia export inputs, provided that these meet Platts' editorial standards. Delivered indications, netted back to an FOB Australia basis, may be considered to test against FOB indications, provided that these inputs reflect sufficient price consistency and repeatability for multiple destinations. The Platts freight assessment used for the back-calculation of delivered price indications will depend on freight market dynamics.

Price index

TS01034 - TSI Premium Hard Coking Coal FOB East Coast Port Australia

TSI's Premium Hard Coking Coal reference price is calculated as a weighted-average index on an FOB East Coast Port Australia for Australian exports. Relevant ports for the FOB East Coast Port Australia reference prices include the Queensland ports of Dalrymple Bay, Hay Point, Gladstone and Abbot Point; and in New South Wales: Newcastle and Port Kembla. Market data submitted for transactions with specifications in the following ranges are considered and normalized to the standard specifications defined in this guide:

Volatile Matter (ad): 18.0% min – 25.0% max inclusive

Ash (ad): 11.0% max

Total Moisture (ar): 12.0% max

Sulphur (ad): 0.80% max

Phosphorous (ad): 0.09% max

Rvmax: 1.15% min

Fluidity: no upper limit

FSI: 7 min

CSR: 67% min

Total Dilatation: no restriction

Vitrinite: 50% min

Payment:

All payment terms are normalized to 'At sight'

Price assessments

HCCAU00 - HCC 64 mid vol FOB Australia

TS01035 - TSI Hard Coking Coal Australia Export FOB East Coast Port

These assessments are published at parity, following the merger of some of the Platts and TSI metallurgical coal price series, effective June 2018. Platts uses pricing information on FOB Australia basis, but may also consider delivered indications in key consumer markets basis CFR China, India, Europe, Japan or South Korea, Taiwan netted back to FOB Australia basis using assessed Panamax spot freight rates for dry bulk carriers, provided that these inputs reflect sufficient price consistency and repeatability for multiple destinations. Platts publishes daily Panamax spot freight rates between Hay Point port in East

Australia and Qingdao port in North China, and from Hay Point port in East Australia to Paradip port in East India.

Price assessments

PLVHD00 - Hard Coking Coal (Premium Low Vol) FOB Australia (China Netback)

HCCGD00 - Hard Coking Coal (Peak Downs Region) FOB Australia (China Netback)

These freight netback values are calculated by taking the HCC Premium Low Vol CFR China assessment (PLVHC00) and HCC Peak Downs Region CFR China assessment (HCCGC00), and subtracting the Platts daily Panamax spot freight rate from Hay Point, Australia, to Qingdao, China (CDBFA00).

China

Price assessments

PLVHC00 - Premium Low Vol CFR China

HCCGC00 - Peak Downs Region CFR China

HCCCH00 - HCC 64 Mid Vol CFR China

These prices are assessed on the basis of indications received on CFR China basis and reflect the spot transactable value at the close of the assessment period on the day of publishing. Loaded indications on an FOB basis netted forward to a CFR China basis may also be considered to test against CFR indications.

Price assessments

TS01044 - TSI Prem JM25 Coking Coal China Imports CFR Jingtang Port

TS01045 - TSI Hard JM25 Coking Coal China Imports CFR Jingtang Port

Following the merger of some of the TSI and Platts metallurgical coal price series effective June 2018, TSI Prem JM25 Coking Coal China Imports CFR Jingtang Port assessment is published at parity with Premium Low Vol CFR China (PLVHC00); and TSI Hard JM25 Coking Coal China Imports CFR Jingtang Port is published at parity with HCC 64 Mid Vol CFR China (HCCCH00),

India

Price assessments

PLVHI00 - Premium Low Vol CFR India

HCCGI00 - Peak Downs Region CFR India

HCCIN00 - HCC 64 Mid Vol CFR India

The Peak Downs Region, Premium Low Vol and HCC 64 Mid Vol assessments on CFR India basis are calculated as a sum of respective FOB Australia assessments and a Panamax dry bulk freight on the Australia-India route (CDBFAI0).

US

Price assessments

AAWWR00 - Low Vol Hard Coking Coal FOB US East Coast

AAWS00 - High Vol A Hard Coking Coal FOB US East Coast

AAWT00 - High Vol B Hard Coking Coal FOB US East Coast

US Low Vol, US High Vol A and US High Vol B Coking Coal indicate the price at which a spot cargo could be traded on a FOB US East Coast basis at the close of the assessment period on the day of publishing. Spot price bids/offers or trades in key consumer markets basis CFR Europe, Brazil, China, India or Japan/Korea/Taiwan may be netted back to FOB US East Coast basis using assessed spot freight rates for dry bulk carriers on the day of assessment, for comparison with spot prices basis FOB US East Coast. For netback calculations from CFR destinations, differing Capesize, Panamax and Handymax freight rates are taken into consideration. Platts assessments also take into account Hard Coking Coal demand/supply fundamentals in the US, Australia and key consumer markets.

Europe

Price assessments

PLVHE00 - Prem Low Vol HCC CFR NWE

Premium Low Vol Hard Coking Coal CFR NW Europe represents a delivered spot price for Australian Premium Low Vol (PLVHA00) in Northwest Europe, calculated by adding daily Platts Capesize freight assessment between Hay Point, Queensland and Rotterdam (CDBUR00) to the Australian benchmark.

SEABORNE PCI COAL

Assessment	CODE	Mavg	Type	Published	Page	Quality	Quantity	Incoterms	Location	Timing	Payment	UOM
Australia												
Low Vol PCI FOB Australia	MCLVA00	MCLVA03	Assessment	Daily	205	13% VM, 8.5% ash, 0.55% sulfur, 7,800 kcal/kg (GAD), 78 HGI, 10% TM, 90.5% total carbon (DAF)	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight	\$/mt
Mid Tier PCI FOB Australia	MCLAA00	MCLAA03	Assessment	Daily	205	15% VM, 12% ash, 0.55% sulfur, 80 HGI, 10% TM, 1 CSN	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight	\$/mt
China												
Low Vol PCI CFR China	MCLVC00	MCLVC03	Assessment	Daily	205	13% VM, 8.5% ash, 0.55% sulfur, 7,800 kcal/kg (GAD), 78 HGI, 10% TM, 90.5% total carbon (DAF)	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Mid Tier PCI CFR China	MCLAC00	MCLAC03	Assessment	Daily	205	15% VM, 12% ash, 0.55% sulfur, 80 HGI, 10% TM, 1 CSN	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
India												
Low Vol PCI CFR India	MCLVI00	MCLVI03	Assessment	Daily	205	13% VM, 8.5% ash, 0.55% sulfur, 7,800 kcal/kg (GAD), 78 HGI, 10% TM, 90.5% total carbon (DAF)	Min 10,000 mt	CFR	Paradip, India	Delivered 20-65 days forward	L/C at sight	\$/mt
Mid Tier PCI CFR India	MCVAI00	MCVAI03	Assessment	Daily	205	15% VM, 12% ash, 0.55% sulfur, 80 HGI, 10% TM, 1 CSN	Min 10,000 mt	CFR	Paradip, India	Delivered 20-65 days forward	L/C at sight	\$/mt

Seaborne PCI Coal

Australia

Price assessments

MCLVA00 - Low Vol PCI FOB Australia

MCLAA00 - Mid-Tier PCI FOB Australia

These prices are assessed on the basis of indications received on FOB Australia basis and reflect the spot transactable value at the close of the assessment period on the day of publishing. Platts uses pricing information on FOB Australia basis, but may also consider delivered indications in key consumer markets basis CFR China, India, Europe, Japan or South Korea, Taiwan netted back to FOB Australia basis using assessed Panamax spot freight rates for dry bulk carriers, provided that these inputs

reflect sufficient price consistency and repeatability for multiple destinations. Platts also monitors the opportunity cost of high quality Australian PCI, which may be derived by observing spot trades of run-of-mine material and through energy-adjusted calculations relating to thermal coal prices.

China

Price assessments:

MCLVC00 - Low Vol PCI CFR China

MCLAC00 - Mid-Tier PCI CFR China

These prices are assessed on the basis of indications received on CFR China basis and reflect the spot transactable value at the close of the assessment period on the day of publishing. Loaded indications on an FOB basis netted forward to a CFR

China basis may also be considered to test against CFR indications. Besides price points for PCI, Platts may also take into consideration daily price movements in the thermal coal markets.

India

Price assessments:

MCLVI00 - Low Vol PCI CFR India

MCVAI00 - Mid-Tier PCI CFR India

The CFR India price are net forwards, calculated as a sum of respective FOB Australia assessments and a Panamax dry bulk freight on the Australia-India route (CDBFAI0).

PENALTIES AND PREMIA FOR SEABORNE HCC

Assessment	CODE	Mavg	Type	Published	Page	Quality	Quantity	Incoterms	Location	Payment	UOM
Asia-Pacific											
CSR per 1% as % PLV FOB Australia	CPCSA00		Assessment	Daily	205	Penalty/premia applied for 60-71% Coal Strength After Reaction	min 10,000 mt	FOB	Hay Point, Australia	L/C at sight	%
CSR per 1% PLV \$/Mt	CPCSP00		Assessment	Daily	205	Penalty/premia applied for 60-71% Coal Strength After Reaction	min 10,000 mt	FOB	Hay Point, Australia	L/C at sight	\$/mt
Sulfur per 0.1% PLV \$/Mt FOB Australia	CPSPA00		Assessment	Daily	205	Penalty/premia applied for 0.3-1% Sulfur	min 10,000 mt	FOB	Hay Point, Australia	L/C at sight	%
Sulfur per 0.1% PLV \$/Mt	CPSPV00		Assessment	Daily	205	Penalty/premia applied for 0.3-1% Sulfur	min 10,000 mt	FOB	Hay Point, Australia	L/C at sight	\$/mt
VM per 1% as % PLV FOB Australia	CPVPA00		Assessment	Daily	205	Penalty/premia applied for 18-27% Volatile Matter	min 10,000 mt	FOB	Hay Point, Australia	L/C at sight	%
VM per 1% PLV \$/Mt	CPVMP00		Assessment	Daily	205	Penalty/premia applied for 18-27% Volatile Matter	min 10,000 mt	FOB	Hay Point, Australia	L/C at sight	\$/mt
TM per 1% as % PLV FOB Australia	CPTPA00		Assessment	Daily	205	Penalty/premia applied for 8-11% Total Moisture	min 10,000 mt	FOB	Hay Point, Australia	L/C at sight	%
TM per 1% PLV \$/Mt	CPTMP00		Assessment	Daily	205	Penalty/premia applied for 8-11% Total Moisture	min 10,000 mt	FOB	Hay Point, Australia	L/C at sight	\$/mt
Ash per 1% as % PLV FOB Australia	CPAPA00		Assessment	Daily	205	Penalty/premia applied for 7-10.5% Ash	min 10,000 mt	FOB	Hay Point, Australia	L/C at sight	%
Ash per 1% PLV \$/Mt	CPPAP00		Assessment	Daily	205	Penalty/premia applied for 7-10.5% Ash	min 10,000 mt	FOB	Hay Point, Australia	L/C at sight	\$/mt
Atlantic											
CSR per 1% as % US LV FOB USEC	CPPBA00		Assessment	Daily	1049	Penalty/premia applied for 50-64% Coal Strength After Reaction	min 10,000 mt	FOB	Hampton Roads, US	L/C at sight	%
CSR per 1% US LV FOB USEC \$/mt	CPPBB00	CB8B803	Assessment	Daily	1049	Penalty/premia applied for 50-64% Coal Strength After Reaction	min 10,000 mt	FOB	Hampton Roads, US	L/C at sight	\$/mt
CSR per 1% as % US LV FOB USEC	CPPBC00		Assessment	Daily	1049	Penalty/premia applied for 40-49% Coal Strength After Reaction	min 10,000 mt	FOB	Hampton Roads, US	L/C at sight	%
CSR per 1% US LV FOB USEC \$/mt	CPPBD00	CPPBD03	Assessment	Daily	1049	Penalty/premia applied for 40-49% Coal Strength After Reaction	min 10,000 mt	FOB	Hampton Roads, US	L/C at sight	\$/mt
Sulfur per 0.1% as % US LV FOB USEC	CPPBE00		Assessment	Daily	1049	Penalty/premia applied for 0.7-1.05% Sulfur	min 10,000 mt	FOB	Hampton Roads, US	L/C at sight	%
Sulfur per 0.1% US LV FOB USEC \$/mt	CPPBF00	CPPBF03	Assessment	Daily	1049	Penalty/premia applied for 0.7-1.05% Sulfur	min 10,000 mt	FOB	Hampton Roads, US	L/C at sight	\$/mt
Sulfur per 0.1% as % US LV FOB USEC	CPPBG00		Assessment	Daily	1049	Penalty/premia applied for 1.06-1.25% Sulfur	min 10,000 mt	FOB	Hampton Roads, US	L/C at sight	%
Sulfur per 0.1% US LV FOB USEC \$/mt	CPPBH00	CPPBH03	Assessment	Daily	1049	Penalty/premia applied for 1.06-1.25% Sulfur	min 10,000 mt	FOB	Hampton Roads, US	L/C at sight	\$/mt
TM per 1% as % US LV FOB USEC	CPPBK00		Assessment	Daily	1049	Penalty/premia applied for 6-11% Total Moisture	min 10,000 mt	FOB	Hampton Roads, US	L/C at sight	%
TM per 1% US FOB USEC LV \$/mt	CPPBL00	CPPBL03	Assessment	Daily	1049	Penalty/premia applied for 6-11% Total Moisture	min 10,000 mt	FOB	Hampton Roads, US	L/C at sight	\$/mt
Ash per 1% as % US LV FOB USEC	CPPBI00		Assessment	Daily	1049	Penalty/premia applied for 5-10% Ash	min 10,000 mt	FOB	Hampton Roads, US	L/C at sight	%
Ash per 1% US LV FOB USEC \$/mt	CPPBJ00	CPPBJ03	Assessment	Daily	1049	Penalty/premia applied for 5-10% Ash	min 10,000 mt	FOB	Hampton Roads, US	L/C at sight	\$/mt

BRAND RELATIVITIES

Assessment	Code	Mavg	Type	Published	Page	Quality	Quantity	Incoterms	Location	Timing	Payment	UOM
China												
Carborough Downs	MCBA000	MCBA003	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
German Creek	MCBAC00	MCBAC03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Goonyella C	MCBAI00	MCBAI03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Goonyella	MCBAE00	MCBAE03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
GLV	MCBAF00	MCBAF03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Illawarra	MCBAH00	MCBAH03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Lake Vermont	MCBAN00	MCBAN03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Middlemount Coking	MCBAP00	MCBAP03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Moranbah North	MCBAG00	MCBAG03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Oaky North	MCBAR00	MCBAR03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Peak Downs	MCBAA00	MCBAA03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Peak Downs North	MCBAJ00	MCBAJ03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Poitrel Semi Hard	MCBAQ00	MCBAQ03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Riverside	MCRVR00	MCRVR03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Saraji	MCBAB00	MCBAB03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Australia												
German Creek	HCGCA00	HCGCA03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	FOB	Australia	Loading 7-45 days forward	L/C at sight	\$/mt
Goonyella C	HCGNA00	HCGNA03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	FOB	Australia	Loading 7-45 days forward	L/C at sight	\$/mt
Goonyella	HCGOA00	HCGOA03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	FOB	Australia	Loading 7-45 days forward	L/C at sight	\$/mt
GLV	HCHCA00	HCHCA03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	FOB	Australia	Loading 7-45 days forward	L/C at sight	\$/mt
Illawarra	HCIWA00	HCIWA03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	FOB	Australia	Loading 7-45 days forward	L/C at sight	\$/mt
Moranbah North	HCMOA00	HCMOA03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	FOB	Australia	Loading 7-45 days forward	L/C at sight	\$/mt
Oaky North	HCOKA00	HCOKA03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	FOB	Australia	Loading 7-45 days forward	L/C at sight	\$/mt
Peak Downs	HCPDA00	HCPDA03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	FOB	Australia	Loading 7-45 days forward	L/C at sight	\$/mt
Peak Downs North	HCPNA00	HCPNA03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	FOB	Australia	Loading 7-45 days forward	L/C at sight	\$/mt
Riverside	HCRVA00	HCRVA03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	FOB	Australia	Loading 7-45 days forward	L/C at sight	\$/mt
Saraji	HCSAA00	HCSAA03	Assessment	Daily	1064	as per typical specifications	Min 10,000 mt	FOB	Australia	Loading 7-45 days forward	L/C at sight	\$/mt
Atlantic												
Blue Creek No. 7	MCAPB04	MCAPB03	Assessment	Weekly	1065	as per typical specifications	Min 10,000 mt	FOB	Mobile, US Gulf	Loading 14-60 days forward	L/C at sight	\$/mt
Blue Creek No. 4	MCAPC04	MCAPC03	Assessment	Weekly	1065	as per typical specifications	Min 10,000 mt	FOB	Mobile, US Gulf	Loading 14-60 days forward	L/C at sight	\$/mt
Beckley	MCAPD04	MCAPD03	Assessment	Weekly	1065	as per typical specifications	Min 10,000 mt	FOB	Hampton Roads, USEC	Loading 14-60 days forward	L/C at sight	\$/mt
Windber	MCAPE04	MCAPE03	Assessment	Weekly	1065	as per typical specifications	Min 10,000 mt	FOB	Hampton Roads, USEC	Loading 14-60 days forward	L/C at sight	\$/mt
Buchanan	MCAPF04	MCAPF03	Assessment	Weekly	1065	as per typical specifications	Min 10,000 mt	FOB	Hampton Roads, USEC	Loading 14-60 days forward	L/C at sight	\$/mt

*Brand specifications available upon request

Platts Metallurgical Coal Relativities

The published metallurgical coal brands values are assessed by Platts and are not affiliated with or sponsored by the brand owners. The brand specifications Platts uses are typical, based on information gathered from various sources, including but not limited to; brand owners public documents, market participant feedback and engagement. The specifications are constantly monitored and updated as changes become apparent.

APAC

Platts daily metallurgical coal assessments and relativities table provides daily price assessments for various qualities of coking coal including Platts benchmark grades, Premium Low Vol and the Mid Vol marker HCC 64 Mid Vol. The price information provided is determined mostly from transactional data and spot market assessments, but also where applicable from theoretical calculations using value-in-use (VIU).

Platts assesses VIU penalties and premia to help track the relative values of several coal qualities. In calculating a theoretical value-in-use, Platts may apply linear penalties and premia within a certain range for coke strength after reaction

(CSR), volatile matter, total moisture, ash and sulphur and non-linear adjustments for phosphorus, maximum fluidity and vitrinite percentage. Platts may also apply other penalties and premia on an ad-hoc basis to account for additional quality or commercial factors.

However, market observations have a stronger bearing on the relativities than VIU calculations, and theoretical VIU-based relativities are recalibrated by observing spot market data including bids, offers and trades for specific brands, and by observing the tradable or traded spreads between these brands.

The final assessed value is a combination of the observed market activity, the editorial evaluation of the coal attributes and the results offered by the calculations. Particular market events and specific circumstances may also have an influence on the market for coking coal or individual grades. Platts observes and monitors all relevant market information for consideration in its assessments.

US

Platts publishes values for Beckley, Buchanan and Windber brands on FOB Hampton Roads basis; and Blue Creek No.7 and

Blue Creek No. 4 on FOB Mobile, Alabama basis. The US brand relativities reflect a laycan period of 14-60 days forward. Sulfur, ash, volatile matter and phosphorus for US brands are specified on a dry basis.

Platts assesses US metallurgical coal relativities based on the information gathered from the market. In the absence of confirmed bids, offers and transactions, Platts calculates prices for Beckley, Buchanan and Windber brands by applying the published penalty and premia for CSR, moisture, ash and sulfur to the US East Coast Low-Vol HCC (AAWWR00). For the Blue Creek No. 7 and Blue Creek No. 4 brands, in line with the common trading terms for these coals, Platts may use FOB Australia premium coking coal indices (PLVHA00 and TS01035) and take into account the forward curve values for typical laycans,.

The US relativities table is published on Friday or the closest prior business day of the week in the event of a UK public holiday.

SEMI-SOFT COKING COAL

Assessment	CODE	Mavg	Type	Published	Page	Quality	Quantity	Incoterms	Location	Timing	Payment	UOM
Semi Soft FOB Australia	MCSSA00	MCSSA03	Assessment	Daily	205	34% VM, 9.5% TM, 9.25% ash, 0.58% sulfur, 0.025% phosphorus, 53% fixed carbon, 200 ddpm max fluidity, 5.5 CSN	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight	\$/mt
Semi Soft CFR China	MCSSC00	MCSSC03	Assessment	Daily	205	34% VM, 9.5% TM, 9.25% ash, 0.58% sulfur, 0.025% phosphorus, 53% fixed carbon, 200 ddpm max fluidity, 5.5 CSN	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	\$/mt
Semi Soft CFR India	MCSSI00	MCSSI03	Assessment	Daily	205	34% VM, 9.5% TM, 9.25% ash, 0.58% sulfur, 0.025% phosphorus, 53% fixed carbon, 200 ddpm max fluidity, 5.5 CSN	Min 10,000 mt	CFR	Paradip, India	Delivered 22-65 days forward	L/C at sight	\$/mt

Semi-Soft Coking Coal

Australia

Price assessments

MCSSA00 – Semi-Soft Coking Coal FOB Australia

Platts publishes the transactable value for Semi-Soft Coking Coal, indicating the price at which a cargo could be traded at the close of the assessment period on the day of publishing. Platts uses pricing information on FOB Australia basis, but may also consider delivered indications in key consumer markets basis CFR China, India, Europe, Japan or South Korea, Taiwan netted back to FOB Australia basis using assessed Panamax spot freight rates for dry bulk carriers, provided that these inputs

reflect sufficient price consistency and repeatability for multiple destinations. Besides price points for semi-soft coking coal, Platts may also take into consideration daily price movements in the thermal coal markets.

China

Price assessments

MCSSC00 – Semi-Soft Coking Coal CFR China

Platts publishes the transactable value for Semi-Soft Coking Coal, indicating the price at which a cargo could be traded at the close of the assessment period on the day of publishing. Platts uses pricing information on CFR China basis, but loaded indications on an FOB basis netted forward to a CFR China basis

may also be considered to test against CFR indications. Besides price points for semi-soft coking coal, Platts may also take into consideration daily price movements in the thermal coal markets.

India

Price assessments

MCSSI00 – Semi-Soft Coking Coal CFR India

Platts publishes the transactable value for Semi-Soft Coking Coal, indicating the price at which a cargo could be traded at the close of the assessment period on the day of publishing. The CFR India price are net forwards, calculated as a sum of respective FOB Australia assessments and a Panamax dry bulk freight on the Australia-India route (CDBFAI0).

METALLURGICAL COKE

Assessment	CODE	Mavg	Wavg	Type	Frequency	Page	Quality	Quantity	Incoterms	Location	Timing	Payment	UOM
China (Seaborne)													
Coke 12.5% Ash FOB Tianjin China	AAWVL00	AAWVL03	AAWVL04	Assessment	Daily	205	64/62% CSR, 12.5% ash, 0.65% sulfur, 82% min Micum 40, 8% max Micum 10, 30-80 mm size, 25-26% CRI, 5% TM	Min 10,000 mt	FOB	Tianjin, China	Loading 7-45 L/C at sight days forward		\$/mt
Met Coke 66/65 CSR FOB North China	MCCNC00	MCCNC03		Assessment	Daily	205	66/65% CSR, 12.5% ash, 0.65% sulfur, 84% min Micum 40, 7% max Micum 10, 30-90 mm size, 25% CRI, 5% TM	Min 10,000 mt	FOB	Tianjin, China	Loading 7-45 L/C at sight days forward		\$/mt
Met Coke 65/63 CSR FOB North China	MCCHB00	MCCHB03		Assessment	Daily	205	65/63% CSR, 12.5% ash, 0.65% sulfur, 82% min Micum 40, 8% max Micum 10, 30-80 mm size, 25%-26% CRI, 5% TM	Min 10,000 mt	FOB	Tianjin, China	Loading 7-45 L/C at sight days forward		\$/mt
Met Coke 62/60 CSR FOB North China	MCCHA00	MCCHA03		Assessment	Daily	205	62/60% CSR, 12.5% ash, 0.65% sulfur, 82% min Micum 40, 8% max Micum 10, 30-80 mm size, 25%-26% CRI, 5% TM	Min 10,000 mt	FOB	Tianjin, China	Loading 7-45 L/C at sight days forward		\$/mt
China (Domestic)													
Coke 12.5% Ash DDP North China Yuan/mt	AAWVJ00	AAWVJ03	AAWVJ04	Assessment	Weekly	1052	62% CSR, 12.5% ash, 0.65% sulfur, 82% min Micum 40, 8% max Micum 10, 30-80 mm size, 25-26% CRI, 5% TM	Min 300 mt	DDP	Tangshan, China	Dispatched within 30 days	L/C 90 days	Yuan/mt
Coke 12.5% Ash DDP North China	AAWVK00	AAWVK03	AAWVK04	Calculation	Weekly	1052	62% CSR, 12.5% ash, 0.65% sulfur, 82% min Micum 40, 8% max Micum 10, 30-80 mm size, 25-26% CRI, 5% TM	Min 300 mt	DDP	Tangshan, China	Dispatched within 30 days	L/C 90 days	\$/mt
Met Coke 62% CSR FOB North China Equivalent	PLVHM04	PLVHM03		Assessment	Weekly	1052	62% CSR, 12.5% ash, 0.65% sulfur, 82% min Micum 40, 8% max Micum 10, 30-80 mm size, 25-26% CRI, 5% TM	NA	FOB	North China	NA	NA	\$/mt
Met Coke 62% CSR Export-Domestic FOB North China Differential	PLVHN04	PLVHN03		Calculation	Weekly	1052	NA	NA	NA	NA	NA	NA	\$/mt
India (Seaborne)													
Met Coke CFR East India	MCCEI00	MCCEI03		Assessment	Daily	205	64/62% CSR, 12.5% ash, 0.65% sulfur, 82% min Micum 40, 8% max Micum 10, 30-80 mm size, 25-26% CRI, 5% TM	Min 5,000 mt	CFR	Paradip, India	Delivered 22-65 days forward	L/C at sight	\$/mt
Met Coke 66/65 CSR CFR India	MCCNI00	MCCNI03		Assessment	Daily	205	66/65% CSR, 12.5% ash, 0.65% sulfur, 84% min Micum 40, 7% max Micum 10, 30-90 mm size, 25% CRI, 5% TM	Min 10,000 mt	CFR	Paradip, India	Delivered 22-65 days forward	L/C at sight	\$/mt
Met Coke 65/63 CSR CFR India	MCINB00	MCINB03		Assessment	Daily	205	65/63% CSR, 12.5% ash, 0.65% sulfur, 82% min Micum 40, 8% max Micum 10, 30-80 mm size, 25%-26% CRI, 5% TM	Min 10,000 mt	CFR	Paradip, India	Delivered 22-65 days forward	L/C at sight	\$/mt
Met Coke 62/60 CSR CFR India	MCINA00	MCINA03		Assessment	Daily	205	62/60% CSR, 12.5% ash, 0.65% sulfur, 82% min Micum 40, 8% max Micum 10, 30-80 mm size, 25%-26% CRI, 5% TM	Min 10,000 mt	CFR	Paradip, India	Delivered 22-65 days forward	L/C at sight	\$/mt

Metallurgical Coke

China

Price assessments

MCCNC00 - Met Coke 66/65 CSR FOB North China

MCCHB00 - Met Coke 65/63 CSR FOB North China

AAWVL00 - Met Coke FOB North China

MCCHA00 - Met Coke 62/60 CSR FOB North China

These prices reflect transactable values on an FOB North China basis at the close of the assessment period on the day of publishing. The CSR range for each assessment refers to the “minimum guaranteed/rejection” range, for example, met coke with a 66%/65% CSR refers to a minimum 66% CSR guaranteed, with rejection for CSR below 65%. Met Coke FOB North China (AAWVL00) assessment specifies a minimum 64% CSR guaranteed, with rejection for CSR below 62%.

Domestic Chinese

Price assessments

AAWVJ00 - Met Coke DDP North China Yuan/mt

AAWVK00 - Met Coke DDP North China \$/mt

PLVHM04 - Met Coke 62% CSR FOB North China Equivalent Weekly

PLVHN04 - Met Coke 62% CSR Export-Domestic FOB North China Differential

Platts publishes the transactable value for Met Coke on a DDP North China basis at the close of the assessment period on Friday. The price is assessed in Yuan/mt and is also converted into \$/mt.

The Met Coke 62% CSR FOB North China Equivalent is a calculation from the domestic DDP China coke assessment (AAWVJ00), normalized for payment terms, logistics cost and exchange rate to FOB North China basis. In addition to the

outright price, Platts also publishes its differential to Platts 64/62% CSR Met Coke FOB North China assessment (AAWVL00).

India

Price assessments:

MCCNI00 - Met Coke 66/65 CSR CFR India

MCINB00 - Met Coke 65/63 CSR CFR India

MCCEI00 - Met Coke CFR East India

MCINA00 - Met Coke 62/60 CSR CFR India

These prices reflect the transactable value of Met Coke on a CFR East India basis at the close of the assessment period on the day of publishing. The CSR range for each assessment refers to the “minimum guaranteed/rejection” range, for example, met coke with a 66%/65% CSR refers to a minimum 66% CSR guaranteed, with rejection for CSR below 65%. Met Coke CFR East India (MCCEI00) assessment specifies a minimum 64% CSR guaranteed, with rejection for CSR below 62%.

DERIVATIVES

Assessment	CODE	Mavg	Type	Frequency	Page	Quality	Quantity	Location	Timing	UOM
TSI Premium Hard Coking Coal FOB Australia Derivative Mo01	MCPLM01	MCPLM13	Assessment	Daily	1113	Basis TSI PHCC FOB Australia index	NA	NA	First month after month of prevailing index date	\$/mt
TSI Premium Hard Coking Coal FOB Australia Derivative Mo02	MCPLM02	MCPLM23	Assessment	Daily	1113	Basis TSI PHCC FOB Australia index	NA	NA	Second month after month of prevailing index date	\$/mt
TSI Premium Hard Coking Coal FOB Australia Derivative Mo03	MCPLM03	MCPLM33	Assessment	Daily	1113	Basis TSI PHCC FOB Australia index	NA	NA	Third month after month of prevailing index date	\$/mt
TSI Premium Hard Coking Coal FOB Australia Derivative Qr01	MCPLQ01	MCPLQ13	Assessment	Daily	1113	Basis TSI PHCC FOB Australia index	NA	NA	First quarter after month of prevailing index date	\$/mt
TSI Premium Hard Coking Coal FOB Australia Derivative Qr02	MCPLQ02	MCPLQ23	Assessment	Daily	1113	Basis TSI PHCC FOB Australia index	NA	NA	Second quarter after month of prevailing index date	\$/mt
TSI Premium Hard Coking Coal FOB Australia Derivative Qr03	MCPLQ03	MCPLQ33	Assessment	Daily	1113	Basis TSI PHCC FOB Australia index	NA	NA	Third quarter after month of prevailing index date	\$/mt
TSI Premium Hard Coking Coal FOB Australia Derivative Yr01	MCPLY01	MCPLY13	Assessment	Daily	1113	Basis TSI PHCC FOB Australia index	NA	NA	First calendar year after month of prevailing index date	\$/mt
TSI Premium Hard Coking Coal FOB Australia Derivative Yr02	MCPLY02		Assessment	Daily	1113	Basis TSI PHCC FOB Australia index			Second calendar year after month of prevailing index date	\$/mt

Derivatives

Platts publishes daily assessments for monthly, quarterly and calendar year TSI PHCC derivatives. These financial instruments are traded at a fixed price or in intermonth spreads. These derivatives settle off the average value of the underlying physical price TSI index for PHCC FOB Australia (TS01034), as published on each day during the month of trade. Platts publishes derivatives assessments for three months ahead, called month one (Mo01), second month (Mo02) and third month (Mo03). Platts also publishes assessments for the next three calendar quarterly derivatives, and for the next two calendar years. Monthly assessments roll on the first day of the month. Quarters

are defined as calendar quarters, for example Q3 refers to July, August and September. Quarterly derivatives assessments roll four times a year on the first business days of January, April, July and October. A year is defined as a calendar year, for example 2020, i.e. from the first to the last business working day in that year.

For example, during October 2019 the Mo01 coking coal derivative is November 2019, Mo02 is December 2019, Mo03 is January 2020, while the first published quarterly derivative is Q1 2020. On November 1, the Mo01 coking coal derivative rolls to December, Mo02 rolls to January, Mo03 rolls to February and the quarterly derivative remains Q1 2020.

DOMESTIC CHINESE

Assessment	CODE	Mavg	Wavg	Type	Frequency	Page	QUALITY	QUANTITY	INCOTERMS	LOCATION	TIMING	PAYMENT	UOM
Ex-Washing Plant													
PCC Met Shanxi Premium Low Vol Ex-washing plant	PCCMA04	PCCMA03		Assessment	Weekly	1050	68% CSR, 16.9% VM (ad), 9.3% ash (ad), 8% TM (ar), 0.6% sulfur (ad), 85 G-value	Min 1,000 mt	Ex-washing plant	Lvliang, Shanxi, China	Loading in 3-30 days	L/C 180 days	Yuan/mt
PCC Met Shanxi High Sulfur Premium Low Vol Ex-washing plant	PCCMD04	PCCMD03		Assessment	Weekly	1050	68% CSR, 19.5% VM (ad), 10.8% ash (ad), 8% TM (ar), 1.6% sulfur (ad), 85 G-value	Min 1,000 mt	Ex-washing plant	Lvliang, Shanxi, China	Loading in 3-30 days	L/C 180 days	Yuan/mt
PCC Met Shanxi PCI Ex-washing plant	PCCMH04	PCCMH03		Assessment	Weekly	1050	9.3% VM (ad), 10.8% ash (ad), 8% TM (ar), 0.5% sulfur (ad)	Min 1,000 mt	Ex-washing plant	Changzhi, Shanxi, China	Loading in 3-30 days	L/C 180 days	Yuan/mt
PCC Met Shandong Semi Soft Ex-washing plant	PCCMK04	PCCMK03		Assessment	Weekly	1050	29.6% VM (ad), 8.3% (ad), 8% TM (ar), 0.6% sulfur (ad), 70 G-value	Min 1,000 mt	Ex-washing plant	Jining, Shandong, China	Loading in 3-30 days	L/C 180 days	Yuan/mt
Free-on-Rail													
PCC Met Shanxi Premium Low Vol Free-on-Rail	PCCMB04	PCCMB03		Assessment	Weekly	1050	68% CSR, 16.9% VM (ad), 9.3% ash (ad), 8% TM (ar), 0.6% sulfur (ad), 85 G-value	Min 1,000 mt	Free-on-rail	Lvliang, Shanxi, China	Loading in 3-30 days	L/C 180 days	Yuan/mt
PCC Met Shanxi High Sulfur Premium Low Vol Free-on-Rail	PCCME04	PCCME03		Assessment	Weekly	1050	68% CSR, 19.5% VM (ad), 10.8% ash (ad), 8% TM (ar), 1.6% sulfur (ad), 85 G-value	Min 1,000 mt	Free-on-rail	Lvliang, Shanxi, China	Loading in 3-30 days	L/C 180 days	Yuan/mt
PCC Met Shanxi PCI Free-on-Rail	PCCMI04	PCCMI03		Assessment	Weekly	1050	9.3% VM (ad), 10.8% ash (ad), 8% TM (ar), 0.5% sulfur (ad)	Min 1,000 mt	Free-on-rail	Changzhi Shanxi, China	Loading in 3-30 days	L/C 180 days	Yuan/mt
PCC Met Shandong Semi Soft Free-on-Rail	PCCML04	PCCML03		Assessment	Weekly	1050	29.6% VM (ad), 8.3% (ad), 8% TM (ar), 0.6% sulfur (ad), 70 G-value	Min 1,000 mt	Free-on-rail	Jining, Shandong, China	Loading in 3-30 days	L/C 180 days	Yuan/mt
DDP Tangshan													
PCC Met Shanxi Premium Low Vol DDP Tangshan	PCCMC04	PCCMC03		Assessment	Weekly	1050	68% CSR, 16.9% VM (ad), 9.3% ash (ad), 8% TM (ar), 0.6% sulfur (ad), 85 G-value	Min 1,000 mt	DDP	Tangshan, China	Loading in 3-30 days	L/C 180 days	Yuan/mt
Met Coal Prem Low Vol Shanxi CFR China Equivalent	PLVHJ04	PLVHJ03		Calculation	Weekly	1050	68% CSR, 16.9% VM (ad), 9.3% ash (ad), 8% TM (ar), 0.6% sulfur (ad), 85 G-value	NA	CFR	China	NA	NA	\$/mt
Met Coal Prem Low Vol Import-Shanxi CFR China Differential	PLVHK04	PLVHK03		Calculation	Weekly		NA	NA	NA	NA	NA	NA	\$/mt
PCC Met Shanxi High Sulfur Premium Low Vol DDP Tangshan	PCCMF04	PCCMF03		Assessment	Weekly	1050	68% CSR, 19.5% VM (ad), 10.8% ash (ad), 8% TM (ar), 1.6% sulfur (ad), 85 G-value	Min 1,000 mt	DDP	Tangshan, China	Loading in 3-30 days	L/C 180 days	Yuan/mt
PCC Met North China Fat Coal DDP Tangshan	PCCMG04	PCCMG03		Assessment	Weekly	1050	55% CSR, 25.4% VM (ad), 9.8% ash (ad), 8% TM (ar), 1.2% sulfur (ad), 90 G-value	Min 1,000 mt	DDP	Tangshan, China	Loading in 3-30 days	L/C 180 days	Yuan/mt
PCC Met Shanxi PCI DDP Tangshan	PCCMJ04	PCCMJ03		Assessment	Weekly	1050	9.3% VM (ad), 10.8% ash (ad), 8% TM (ar), 0.5% sulfur (ad)	Min 1,000 mt	DDP	Tangshan, China	Loading in 3-30 days	L/C 180 days	Yuan/mt
Ex-Stock Jingtang													
Prem Low Vol Ex-Stock Jingtang	AAWZN00	AAWZN03	AAWZN04	Assessment	Weekly	1062	71% CSR, 21.5% VM, 9.7% TM, 9.3% ash, 0.5% sulfur, 0.045% phosphorus, 500 ddpm maximum fluidity, 65% vitrinite	10,000-20,000 mt	Ex-stock	Jingtang port, China	Delivered 20 days forward	Cash	Yuan/mt
HCC 64 Mid Vol Ex-Stock Jingtang	AAWZP00	AAWZP03		Assessment	Weekly	1062	62% CSR, 21.5% VM, 10.5% TM, 8% ash, 0.45% sulfur, 0.06% phosphorus, 100 ddpm max fluidity, 52% vitrinite	10,000-20,000 mt	Ex-stock	Jingtang port, China	Delivered 20 days forward	Cash	Yuan/mt
CFR Jintang Equivalents													
Prem Low Vol CFR Jingtang Equivalent	AAWZ000	AAWZ003		Calculation	Weekly	1062	71% CSR, 21.5% VM, 9.7% TM, 9.3% ash, 0.5% sulfur, 0.045% phosphorus, 500 ddpm maximum fluidity, 65% vitrinite	10,000-20,000 mt	CFR	Jingtang port, China	Delivered 20 days forward	Cash	\$/mt

DOMESTIC CHINESE

Assessment	CODE	Mavg	Wavg	Type	Frequency	Page	QUALITY	QUANTITY	INCOTERMS	LOCATION	TIMING	PAYMENT	UOM
Met Coal Prem Low Vol Import-Port Stock CFR China Differential	PLVHL04	PLVHL03		Calculation	Weekly	1062	71% CSR, 21.5% VM, 9.7% TM, 9.3% ash, 0.5% sulfur, 0.045% NA phosphorus, 500 ddp maximum fluidity, 65% vitrinite		NA	NA	NA	NA	\$/mt
HCC 64 Mid Vol CFR Jingtang Equivalent	AAWZQ00	AAWZQ03		Calculation	Weekly	1062	62% CSR, 21.5% VM, 10.5% TM, 8% ash, 0.45% sulfur, 0.06% phosphorus, 100 ddp max fluidity, 52% vitrinite	10,000-20,000 mt	CFR	Jingtang port, China	Delivered 20 days forward	Cash	\$/mt
Rail and Truck Freight													
PCC Met Rail Freight Shanxi - Tangshan	PCCMM04	PCCMM03		Assessment	Weekly	1050	NA	Min 1,000 mt	NA	Shanxi - Tangshan	Loading in 3-30 days	L/C 180 days	Yuan/mt
PCC Met Truck Freight Shanxi - Tangshan	PCCM004	PCCM003		Assessment	Weekly	1050	NA	Min 1,000 mt	NA	Shanxi - Tangshan	Loading in 3-30 days	L/C 180 days	Yuan/mt

Domestic Chinese Price Assessments

“PCC Met” series

Price assessments:

PCC Met Shanxi Premium Low Vol

PCC Met Shanxi High Sulfur Premium Low Vol

PCC Met Shanxi PCI

PCC Met Shandong Semi Soft

PCC Met North China Fat Coal

PCC Met price assessments, published Wednesday, reflect the value of five grades of metallurgical coal in the domestic Chinese market on ex-wash plant Lvliang (Shanxi), free-on-rail Lvliang (Shanxi) and delivered, duty paid Tangshan basis in Yuan/mt. In the absence of more specific market information, data from other related locations may be netted back or forward to normalize to the specified location basis, using prevailing rail and truck freight.

Price assessments:

PLVHJ04 - Met Coal Prem Low Vol Shanxi CFR China Equivalent

PLVHK04 - Met Coal Prem Low Vol Import-Shanxi CFR China Differential

Met Coal Prem Low Vol Shanxi CFR China Equivalent (PLVHJ04) is calculated on the basis of Shanxi Premium Low Vol DDP Tangshan (PCCMC04), normalized for payment terms, transportation and logistics costs and exchange rate to reach a CFR equivalent value. In addition to the outright value, Platts publishes a differential (PLVHK04) to PLV HCC CFR China daily price (PLVHC00).

Price assessments:

PCCMM04 - PCC Met Rail Freight Shanxi - Tangshan

PCCM004 - PCC Met Truck Freight Shanxi - Tangshan

Platts publishes two freight assessments in the domestic Chinese market, reflecting rail and truck transportation costs on Shanxi-Tangshan route in Yuan/mt. Freight from Shanxi is normalized to Lvliang.

Jingtang port

Price assessments:

AAWZN00 - Premium Low Vol ex-stock Jingtang, North China

AAWZP00 - HCC 64 mid vol ex-stock Jingtang, North China

These assessments reflect the value of both Chinese domestic and imported coking coal sold for prompt and typical delivery in North China and at North Chinese ports in Yuan/mt, inclusive of VAT. Platts monitors inland spot trade flowing from mines directly to end-users without going through ports for pricing consistency, including for domestic Chinese, Mongolian and Russian metallurgical coal. Platts also monitors prices of seaborne metallurgical coal for pricing consistency.

Price assessments:

AAWZ000 - Prem Low Vol CFR Jingtang Equivalent

AAWZQ00 - HCC 64 Mid Vol CFR Jingtang Equivalent

PLVHL04 - Met Coal Prem Low Vol Import-Port Stock CFR China Differential

CFR Jingtang Equivalents are calculated net forwards from corresponding ex-stock Jingtang assessments, normalized for payment terms, additional transportation and logistics costs and exchange rate to reach a port-equivalent value. These assessments are published on Fridays. In addition to the outright price of the Premium Low Vol CFR Jingtang Equivalent, Platts also publishes its weekly differential to the PLV HCC CFR China assessment (PLVHC00).

Dry Bulk Freight

Platts assesses freight rates for dry bulk cargoes on a variety of routes. Please refer to the Freight specifications guide for details of these assessments https://www.spglobal.com/platts/plattscontent/_assets/_files/en/our-methodology/methodology-specifications/freight-methodology.pdf.

REVISION HISTORY

April 2020: Platts changed US coking coal specifications, extended laycan period for US brand assessments and discontinued Oak Grove brand relativity assessment. Platts updated US coking coal brand methodology to include a combination of market survey, VIU and reference to benchmark indices.

February 2020: Updated to reflect the discontinuation of Standard and Premium CFR China, reflect the name change from Hail Creek to GLV. Updated the specifications for HCC 64 Mid Vol Ex-Stock Jingtang and HCC 64 Mid Vol CFR Jingtang Equivalent.

November 2019: Platts launched 11 FOB Australia met coal brand relativities and Riverside CFR China brand assessment. Specifications Guide Annual Review was conducted and clarifications made. Platts clarified its approach to calculating netbacks, combined description of assessments with similar methodological approach, replaced the description of swaps with “derivatives”, updated links, clarified calculations of differentials, added missing and removed discontinued symbols, and made minor stylistic changes throughout. Moved dry bulk freight assessments into the freight guide. Added TSI PHCC assessment with the associated revision history, and a description of the European HCC assessment. Added a list of commonly used acronyms.

July 2019: Platts updated the guide to include the new daily met coke 65%/63% CSR, 62%/60% CSR assessments launched on January 2, 2019.

June 2019: Updated High Vol A, High Vol B and Low Vol HCC US East Coast price assessments' spot loading period to 14-60 days. Platts completed an annual update to sections 1 to 6 of Platts Methodology and Specifications Guides in April 2019, and moved these sections into a standalone Methodology Guide.

April 2019: Updated to remove Pinnacle US brand relativity after

discontinuation.

November 2018: Methodology & Specifications Guide Annual Review was conducted and clarifications made. Removed specifications for Asia-Pacific brand relativities and US HCC brand relativities which remain available upon request.

July 2018: Updated to reflect basis change of Platts derivatives assessments to reflect the TSI PHCC FOB Australia derivatives contracts. Updated to reflect discontinuations of Oaky Creek and Mavis Downs CFR China relativities, and the launch of Oaky North CFR China relativity.

June 2018: Updated to reflect merger of various TSI metallurgical coal indices with Platts equivalent price series.

May 2018: Updated to reflect change in China's VAT rate.

March 2018: Platts launches Met Coke 66/65 CSR CFR India daily assessment.

February 2018: Platts updates its assessment for Blue Creek No.7 and No. 4 cited in the US brand relativities weekly series.

October 2017: Methodology & Specifications Guide Annual Review was conducted.

August 2017: Updates and amending unit of measurement.

May 2017: Platts updates its assessment for Blue Creek No.4 cited in the US brand relativities weekly series.

November 2016: Methodology & Specifications Guide Annual Review was conducted and clarifications made

September 2016: Platts adds the China PLV, Met Coke Price Differentials series.

June 2016: Platts clarifies 64/62% CSR quality for Met Coke FOB

North China (AAWVL00) & Met Coke CFR East India (MCCEI00). Platts updates South 32's Illawarra specification.

May 2016: Platts adds Premium Low Vol CFR North West Europe net forward.

April 2016: Platts launches Peak Downs Region and Premium Low Vol FOB China Netback series. Platts changes methodology process for Peak Downs Region and Premium Low Vol FOB Australia assessments.

March 2016: Updated to remove the upper limit for permissible fluidity for TSI Premium Hard Coking Coal index - FOB East Coast port, Australia. US brand relativities data updated.

January, 2016: US brand relativities weekly series published.

February 2016: Teck's Standard and Premium specifications revised.

December 2015: Platts launches daily metallurgical coal relativities.

August 2015: Platts launches PCC Met Chinese domestic metallurgical coal price series.

July 2015: Platts discontinues CCI Met Chinese domestic metallurgical coal price series.

April 2015: Platts launches Met Coke 66/65 CSR FOB North China daily assessments.

April 2015: Platts adds methodology for CCI Met china domestic metallurgical coal price assessments.

April 2015: Platts renames Low Vol 12 Ash PCI to Mid-Tier PCI.

March 2015: Platts adds details on monthly met coal relativities.

February 2015: This methodology guide was updated to include further description of Platts' processes and practices in survey assessment environments.

October 2014: Platts increased the frequency of its Met Coke FOB North China (AAWVL00) to daily, from weekly, starting October 1, 2014.

July 2014: Platts revamped all Metals Methodology and Specification guides, including its Metallurgical Coal Methodology Guide, in July 2014. This revamp was completed to enhance the clarity and usefulness of all guides, and to introduce greater consistency of layout and structure across all published methodology guides. Methodologies for market coverage were not changed through this revamp, unless specifically noted in the methodology guide itself.

July 2014: Platts started publishing relativities table at the end of the last working day of each month. Previously, since May 2013, the table showed an average of relativities through the month. Since January 2014 the table represents relativities on a CFR China basis, rather than theoretical FOB Queensland basis.

Javelin Global Commodities (UK) Ltd
Financial Statements for the Year Ended
31 December 2019



CORPORATE INFORMATION

Directors

Mr Peter Michael James Bradley
Mr Spencer Bradley Sloan

Registered Office

7 Howick Place
London
SW1P 1BB
United Kingdom

General Counsel and Company Secretary

Mr Michael John Foster

Bankers

Barclays Bank
Leicester
Leicestershire
LE87 2BB
United Kingdom

Auditors

Ernst & Young LLP
1 More London Place
London
SE1 2AF
United Kingdom

STRATEGIC REPORT

The directors present the Strategic Report of Javelin Global Commodities (UK) Ltd (the 'Company') for the year ended 31 December 2019.

BUSINESS REVIEW

The Company was incorporated on 13 March 2015. The principal activity of the Company is the physical trading and marketing of bulk commodities, together with the management of supply chain logistics and operations involved in the movement of physical cargoes. The Company also trades financial derivative contracts in related markets. Trading activities of the Company commenced in June 2015.

The Company's trading business is supported by a number of agreements with its strategic shareholders including Uniper Global Commodities SE ('Uniper'). Uniper provides margin lines of credit totalling up to \$185mm to support the Company's hedging and derivatives trading.

For the year ended 31 December 2019, the Company earned a profit after taxes of US\$28,602 (in '000).

KEY PERFORMANCE INDICATORS

The Companies Act 2006 requires directors to disclose the Company's key performance indicators (KPIs). The KPIs of the Company for the year ended 31 December 2018 are, in the opinion of the directors, satisfactory and as follows:

	Year Ended 31 December 2019 (\$'000)	Year Ended 31 December 2018 (\$'000)
Revenue	1,469,358	2,008,280
Gross Profit	68,500	100,094
Profit before taxation	35,590	64,408
Profit for the year	28,602	52,494

PRINCIPAL RISK AND UNCERTAINTIES

Physical and financial trading requires prudent management of market, credit, operations and liquidity risks. The directors are committed to ensuring the Company operates adequate and effective risk management processes that evaluate and manage all risks involved in its activities.

Controlling and Risk Management functions have been created and adequate IT systems have been developed internally to manage these risks. The Company is subject to group-wide limits in respect of market risk and credit exposure, which are imposed by the management board of the Company's ultimate parent, Javelin Global Commodities Holdings LLP.

Market risk is calculated by reference to industry standard metrics (e.g. VaR) and monitored through daily mark to market reporting. Credit exposure to individual counterparties is measured by reference to both delivered unpaid and maximum potential exposure to a counterparty over the term of a transaction (MPE), with limits set by reference to the long-term debt ratings set by S&P and Moody's. Any planned increase to or breach of credit or risk limits requires reference to the management board.

Trading activities expose the Company to changes in market conditions including (i) changes in the price of commodities and (ii) changes in the cost of transporting commodities. Commodity prices and transportation costs are influenced by many external factors including supply and demand, production costs in major producing countries and global political and economic conditions. The Company manages market risk through financial swaps, options and other derivative instruments to ensure compliance with the risk limits imposed by the management board.

Currency risk exists, to a small extent, in assets and liabilities of the Company that are not denominated in USD. The commodity markets in which the Company operates are typically denominated in USD which significantly reduces the Company's potential currency exposure.

STRATEGIC REPORT (CONTINUED)

PRINCIPAL RISK AND UNCERTAINTIES (CONTINUED)

Financial assets (e.g. receivables, derivatives instruments) can expose the Company to a concentration of counterparty credit and performance risk. The Company monitors counterparty credit quality and seeks to reduce risk of customer non-performance through credit support where appropriate. The Company makes use of credit enhancement products such as letters of credit, bank guarantees and prepayments when deemed necessary.

The Company is exposed to operational risks such as loss of product and third-party damages claims that result from the transportation and handling of commodities. The Company has insurance in place typical of the industry to cover these risks.

Liquidity of the Company is managed at the Group level. The funding for the Group was secured by provision of capital by the shareholders, third party working capital facilities and committed parent company credit lines.

Key controls exist at the Company to ensure that regulatory requirements are adhered to. Legal and regulatory risks are managed by the Company's internal and external legal counsel. Since its incorporation, the Company has implemented policies in relation to Anti-Bribery and Corruption, Sanctions, Corporate Social Responsibility and 'Know Your Customer'. It has also obtained legal memoranda in relation to the Company's regulatory status. The Company maintains a careful watch on impending regulatory changes likely to affect commodity trading.

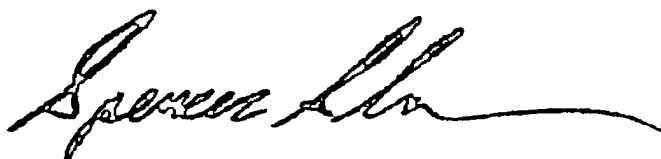
EMPLOYEES

The Company employs trading and operations professionals and is primarily responsible for the Group's physical trading activities in the international market. The Company's physical business involves the trading and marketing of bulk commodities together with the management of supply chain logistics and operations involved in the movement of physical cargoes. The Company also trades financial derivatives in related markets.

Foreign subsidiaries of the Company include Javelin Global Commodities (CH) GmbH, Javelin Global Commodities (IL) Ltd and Javelin Global Commodities (SG) Pte. Ltd. The foreign subsidiaries employ Javelin's global marketing team. The employees market coal for the Company in Europe, South America and Asia.

The directors place high importance on the investments in its employees and ensure that employees are kept informed on matters affecting them. The Company operates a compensation policy clearly documented and linked to the profitability of the business.

Approved by and signed on behalf of the Board of Directors,



Spencer Sloan (Director)

31 July 2020

DIRECTORS' REPORT

The directors present their Directors' Report of Javelin Global Commodities (UK) Ltd (the 'Company') for the year ended 31 December 2019.

DIRECTORS

The directors holding office during year and to date of this report were:

Peter Michael James Bradley

Spencer Bradley Sloan

The directors of the Company had no direct interest in the shares of the Company.

OUTLOOK

For the year ended 31 December 2019, the Company earned a profit after taxes of US\$28,602 (in '000). The Company believes the provision of capital by the shareholders, access to third party working capital facilities and committed parent company credit lines put the Company in a strong financial position to support the business's trading activities.

DIVIDENDS

The Company declared a dividend of \$3.0 million during the current year.

FUTURE DEVELOPMENT

The Company will primarily look to expand its presence in the physical coal market through diversification of supply, end customers and geographic presence. The Company will also continue to opportunistically explore diversification into other commodity markets.

FINANCIAL RISK MANAGEMENT OBJECTIVES AND POLICIES

The Company's financial risk management objectives and policies are disclosed in the Strategic Report and Note 8 of these financial statements.

SECTION 172 STATEMENT

Section 172 of the Companies Act 2006 requires directors to act in a way that they consider, in good faith, would be most likely to promote the success of the Company for the benefit of stakeholders as a whole. In doing so, the directors must have regard (among other matters) to:

- The likely consequences of any decision in the long term.
- The interest of the Company's employees.
- The need to foster business relationships with producers, clients and others.
- The impact of the Company's operations on the community and the environment.
- The desirability of the Company maintaining a reputation for high standards of business conduct.
- The need to act fairly towards all stakeholders of the Company.

The directors determine the strategic objectives and policies of the Company to best support the delivery of long term value, providing overall strategic direction within an appropriate framework of rewards, incentives and controls. The following paragraphs summarises how the directors fulfil their duties:

Risk Management

As we grow our business, the Company is exposed to different and potentially more complex risks. It is therefore vital that we effectively identify, evaluate, manage and mitigate risk and that we continue to evolve our approach to risk management. For details of our principal risks and uncertainties, and how we manage our risk, please refer to the Strategic Report and Note 8 of these financial statements.

DIRECTORS' REPORT (CONTINUED)

SECTION 172 STATEMENT (CONTINUED)

Our People

The Company is committed to being a responsible business. Our behaviour is aligned with the expectation of our people, clients, producers, communities, and society as a whole. For our business to succeed we need to manage our people's performance and development whilst ensuring we operate as efficiently as possible. We must also ensure we share common values that inform and guide our behaviour, so we achieve our goals in the right way. Our employees are fundamental to the delivery of our plan. We aim to be a responsible employer in our approach to the pay and benefits our employees receive. The health, safety and well-being of our employees is one of the primary considerations determining the way our Company operates.

Business Relationships

Our success as a Company is driven, in large part, by our ability to develop and maintain strong client relationships. We value the long-term relationships we have with producers, consumers and others in the commodity value chain. Our commitment to our clients is evident in the often long term nature of our marketing, offtake, sales and financing arrangements.

Community and Environment

The Company's approach is to use our position of strength to create positive change for the people and communities with which we interact. We want to leverage our expertise and enable colleagues to support the communities around us.

Stakeholders

The Board is committed to openly engaging with our stakeholders, as we recognise the importance of continuing effective dialogue, whether with our employees, investors or other stakeholders. It is important to us that stakeholders understand our strategy and objectives, so these must be explained clearly, feedback heard, and any issues or questions raised properly considered.

DIRECTORS' INDEMNITIES

The Company indemnifies the directors in its Articles of Association to the extent allowed under section 232 of the Companies Act 2006. Qualifying third party indemnity provisions in the form of a Directors' and Officers' insurance policy are in place for the benefit of the Company's directors and they remain in force at the date of this report.

CHARITABLE AND POLITICAL DONATIONS

During the year, the Company did not make either charitable or political donations.

POLICY AND PRACTICE WITH RESPECT TO PAYMENT OF SUPPLIERS

It is the Company's policy that payments to suppliers are made in accordance with the terms and conditions agreed between the Company and its suppliers, provided that all relevant trading terms and conditions have been complied with.

SUBSEQUENT EVENT REVIEW

Events subsequent to 31 December 2019 that would materially affect the financial statements are included at Note 32.

GOING CONCERN

The directors have a reasonable expectation that the Company has adequate resources to continue in operational existence for the foreseeable future. As such, the directors continue to adopt the going concern basis of accounting in preparing the annual financial statements.

Javelin Global Commodities Holdings LLP has agreed to provide financial support for a minimum 12-month period from the date of signing these financial statements in order for the Company to continue to meet its liabilities as they fall due. Accordingly, the directors consider it appropriate to prepare the financial statements on a going concern basis.

DIRECTORS' REPORT (CONTINUED)

GOING CONCERN (CONTINUED)

Management has assessed the impact of COVID-19 on the company's ability to operate as a going concern. The company has the financial support from the Group which has sufficient cash and liquidity to fund the Company's operations if necessary. Javelin Global Commodities Holdings LLP has performed stress testing on the combined Javelin Group financial statements which indicates that there is no material risk that the Group will be unable to provide financial support to the Company for a period of at least 12 months from the issuance date of these financial statements. As part of this stress testing, the Group ran a simulation of a worst-case scenario which assumes significant impairments on its current assets and a material reduction in its trading operations. This worst-case scenario demonstrates that the Group would still be able to meet its liabilities as they fall due. In addition, the Company has access to two uncommitted credit facilities with capacity of approximately \$150 million with \$82.4 million of unused spare capacity as of December 31, 2019.

Management deems that with the liquidity available for the Company that it has access to sufficient liquid assets to settle any liabilities as they fall due.

APPOINTMENT OF AUDITOR

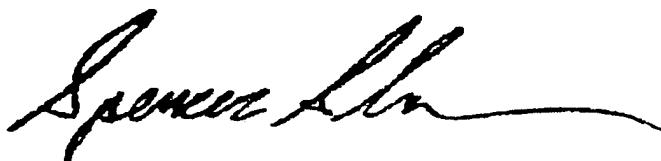
A resolution to reappoint Ernst & Young LLP will be placed before the members at the Annual General Meeting.

DISCLOSURE OF INFORMATION TO AUDITORS

The directors who were members of the board at the time of approving the Directors' Report are listed above. Having made enquiries of fellow directors and the Company's auditor, each of the directors confirms that:

- to the best of each director's knowledge and belief, there is no information (that is information needed by the auditors in connection with preparing their report) of which the Company's auditors are unaware, and
- each director has taken all the steps a director might reasonably be expected to have taken to be aware of relevant audit information and to establish that the Company's auditors are aware of that information.

The Directors' Report comprising pages 4 to 6 including the sections of the financial statements referred to in these pages, has been approved by the Board and signed on its behalf by,



Spencer Sloan (Director)

31 July 2020

DIRECTORS' RESPONSIBILITIES STATEMENT

The directors are responsible for preparing the Strategic report, the Directors' report and the financial statements in accordance with applicable United Kingdom law and regulations.

Company law requires the directors to prepare financial statements for each financial year. Under that law the directors have elected to prepare the financial statements in accordance with International Financial Reporting Standards (IFRS) as adopted by the European Union. Under company law the directors must not approve the financial statements unless they are satisfied that they give a true and fair view of the state of affairs of the Company and the comprehensive income of the Company for that period. In preparing these financial statements, the directors are required to:

- Present fairly the financial position, financial performance and cash flows of the Company;
- Select suitable accounting policies and apply them consistently;
- Make judgments and accounting estimates that are reasonable and prudent;
- Present information, including accounting policies, in a manner that provides relevant, reliable, comparable and understandable information;
- State whether applicable International Financial Reporting Standards as adopted by the European Union have been followed, subject to any material departures disclosed and explained in the financial statements;
- Prepare the financial statements on the going concern basis unless it is inappropriate to presume that the Company will continue in business.

The directors are responsible for keeping adequate accounting records that are sufficient to show and explain the Company's transactions and disclose with reasonable accuracy at any time the financial position of the Company and enable them to ensure that the financial statements comply with the Companies Act 2006. They are also responsible for safeguarding the assets of the Company and hence for taking reasonable steps for the prevention and detection of fraud and other irregularities.

The directors confirm that they have complied with the requirements; have a reasonable expectation that the Company has adequate resources to continue in operational existence for the foreseeable future and continue to adopt the going concern basis in preparing the financial statements.

INDEPENDENT AUDITORS REPORT TO THE MEMBERS OF JAVELIN GLOBAL COMMODITIES (UK) LTD

Opinion

We have audited the financial statements of Javelin Global Commodities (UK) Ltd for the year ended 31 December 2019 which comprise the Statement of Comprehensive Income, the Statement of Financial Position, the Statement of Changes in Equity, the Statement of Cash Flows and the related Notes 1 to 32, including a summary of significant accounting policies. The financial reporting framework that has been applied in their preparation is applicable law and International Financial Reporting Standards (IFRSs) as adopted by the European Union.

In our opinion, the financial statements:

- give a true and fair view of the company's affairs as at 31 December 2019 and of its profit for the year the ended;
- have been properly prepared in accordance with IFRSs as adopted by the European Union; and
- have been prepared in accordance with the requirements of the Companies Act 2006.

Basis for opinion

We conducted our audit in accordance with International Standards on Auditing (UK) (ISAs (UK)) and applicable law. Our responsibilities under those standards are further described in the Auditor's responsibilities for the audit of the financial statements section of our report below. We are independent of the company in accordance with the ethical requirements that are relevant to our audit of the financial statements in the UK, including the FRC's Ethical Standard, and we have fulfilled our other ethical responsibilities in accordance with these requirements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Emphasis of matter – Effects of COVID-19

We draw attention to Note 32 of the financial statements, which describes the economic and social disruption the company is facing as a result of COVID-19 which is impacting commodity prices, demand, trading activities and personnel being able to access offices. Our opinion is not modified in respect of this matter.

Conclusions relating to going concern

We have nothing to report in respect of the following matters in relation to which the ISAs (UK) require us to report to you where:

- the directors' use of the going concern basis of accounting in the preparation of the financial statements is not appropriate; or
- the directors have not disclosed in the financial statements any identified material uncertainties that may cast significant doubt about the company's ability to continue to adopt the going concern basis of accounting for a period of at least twelve months from the date when the financial statements are authorised for issue.

Other information

The other information comprises the information included in the annual report on pages 2 to 6, other than the financial statements and our auditor's report thereon. The members are responsible for the other information

Our opinion on the financial statements does not cover the other information and, except to the extent otherwise explicitly stated in this report, we do not express any form of assurance conclusion thereon. In connection with our audit of the financial statements, our responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial statements or our knowledge obtained in the audit or otherwise appears to be materially misstated. If we identify such material inconsistencies or apparent material misstatements, we are required to determine whether there is a material misstatement in the financial statements or a material misstatement of the other information. If, based on the work we have performed, we conclude that there is a material misstatement of the other information, we are required to report that fact. We have nothing to report in this regard.

Opinion on other matter prescribed by the Companies Act 2006

In our opinion, based on the work undertaken in the course of the audit:

- the information given in the strategic report and the directors' report for the financial year for which the financial statements are prepared is consistent with the financial statements; and
- the strategic report and directors' report have been prepared in accordance with applicable legal requirements.

INDEPENDENT AUDITORS REPORT TO THE MEMBERS OF JAVELIN GLOBAL COMMODITIES (UK) LTD (CONTINUED)

Matters on which we are required to report by exception

In the light of the knowledge and understanding of the company and its environment obtained in the course of the audit, we have not identified material misstatements in the strategic report or directors' report.

We have nothing to report in respect of the following matters in relation to which the Companies Act 2006 requires us to report to you if, in our opinion:

- adequate accounting records have not been kept by the parent company, or returns adequate for our audit have not been received from branches not visited by us; or
- the financial statements are not in agreement with the accounting records and returns; or
- certain disclosures of directors' remuneration specified by law are not made; or
- we have not received all the information and explanations we require for our audit

Responsibilities of directors

As explained more fully in the directors' responsibilities statement set out on page 7, the directors are responsible for the preparation of the financial statements and for being satisfied that they give a true and fair view, and for such internal control as the directors determine is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, the directors are responsible for assessing the company's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless the directors either intend to liquidate the company or to cease operations, or have no realistic alternative but to do so.

Auditor's responsibilities for the audit of the financial statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with ISAs (UK) will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

A further description of our responsibilities for the audit of the financial statements is located on the Financial Reporting Council's website at <https://www.frc.org.uk/auditorsresponsibilities>. This description forms part of our auditor's report.

Use of our report

This report is made solely to the company's members, as a body, in accordance with Chapter 3 of Part 16 of the Companies Act 2006. Our audit work has been undertaken so that we might state to the company's members those matters we are required to state to them in an auditor's report and for no other purpose. To the fullest extent permitted by law, we do not accept or assume responsibility to anyone other than the company and the company's members as a body, for our audit work, for this report, or for the opinions we have formed.

Ernst & Young LLP

Kiran Jamil (Senior statutory auditor)

For and on behalf of Ernst & Young LLP, Statutory Auditor

London

31 July 2020

STATEMENT OF COMPREHENSIVE INCOME
For the year ended 31 December 2019

	Notes	2019 \$'000	2018 \$'000
Revenue	9	1,469,358	2,008,280
Cost of sales	10	(1,400,858)	(1,908,186)
Gross Profit		68,500	100,094
Administrative expenses	11	(29,590)	(33,673)
Impairment loss	11	(8,785)	-
Other income / (loss)	12	7,950	(204)
Operating profit		38,075	66,217
Finance costs	13	(8,405)	(3,798)
Finance income	14	5,920	1,989
Profit before tax from continuing operations		35,590	64,408
Income tax expense	17	(6,988)	(11,914)
Profit for the year from continuing operations		28,602	52,494

Profits for the year are from continuing operations and are wholly attributable to the parent company.

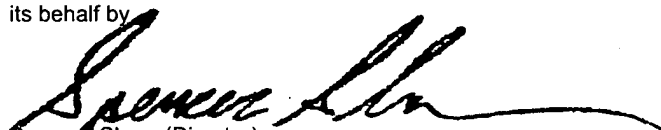
The Company had no other comprehensive income in 2019 and 2018.

The notes on pages 13 to 43 form an integral part of these financial statements.

STATEMENT OF FINANCIAL POSITION
As at 31 December 2019

	Notes	2019 \$'000	2018 \$'000
ASSETS			
Non-current assets			
Intangible assets	19	677	805
Property, plant and equipment	18,20	71,244	2,000
Investment in subsidiaries	21	56	56
Note receivables	24	-	-
Derivative financial instruments	8	39,393	6,827
		<u>111,370</u>	<u>9,688</u>
Current assets			
Inventories	22	72,121	147,654
Trade and other receivables	23	108,058	105,677
Tax receivable		166	195
Note receivables	24	14,470	14,010
Credit facility to Group entity		26,265	-
Other assets	9	10,692	13,684
Cash and short-term deposits	25	67,938	61,511
Derivative financial instruments	8	61,736	118,501
		<u>361,446</u>	<u>461,232</u>
Total Assets		<u>472,816</u>	<u>470,920</u>
LIABILITIES			
Non-current liabilities			
Other non-current liabilities	20	50,814	-
Loans and borrowings	28	22,875	-
Derivative financial instruments	8	5,513	1,738
		<u>79,202</u>	<u>1,738</u>
Current liabilities			
Trade and other payables	27	63,924	188,577
Tax payable	27	7,164	11,643
Other current liabilities	20,27	18,764	12,787
Loans and borrowings from third parties	28	85,391	45,902
Loans and borrowings from Group entity	28	32,048	27,467
Derivative financial instruments	8	21,070	43,155
		<u>228,361</u>	<u>329,531</u>
Total Liabilities		<u>307,563</u>	<u>331,269</u>
Net Assets		<u>165,253</u>	<u>139,651</u>
EQUITY			
Equity attributable to owners of the parent			
Issued capital	26	10,000	10,000
Retained earnings	26	155,253	129,651
Total Equity		<u>165,253</u>	<u>139,651</u>

The financial statements were authorised for issue by the Board of Directors on 31 July 2020 and were signed on its behalf by


 Spencer Sloan (Director)
 31 July 2020

The notes on pages 13 to 43 form an integral part of these financial statements.

STATEMENT OF CHANGES IN EQUITY
For the year ended 31 December 2019

		Share Capital	Retained Earnings	Total Equity
	Notes	\$'000	\$'000	\$'000
Balance at 31 December 2017		10,000	104,362	114,362
Profit for the period		-	52,494	52,494
Issue of share capital		-	(27,205)	(27,205)
Balance at 31 December 2018		10,000	129,651	139,651
Profit for the year		-	28,602	28,602
Dividends to shareholders		-	(3,000)	(3,000)
Balance at 31 December 2019	26	10,000	155,253	165,253

The notes on pages 13 to 43 form an integral part of these financial statements.

STATEMENT OF CASH FLOWS**For the year ended 31 December 2019**

	Notes	1 January to 31 December 2019 \$'000	1 January to 31 December 2018 (restated) \$'000
Operating Activities			
Profit before tax from continuing operations		35,590	64,408
Adjustments to reconcile profit before tax to net cash flows:			
Depreciation and amortisation		1,924	241
Interest expense for leases		373	-
Write off of property plant and equipment		-	204
Changes in:			
Inventories		75,533	(67,308)
Trade and other receivables		(2,505)	3,492
Other assets		2,992	3,464
Derivative financial instruments		5,890	(41,508)
Trade and other payables		(117,789)	62,244
Other current liabilities		(11,754)	10,339
Other non-current liabilities		-	(4,265)
Cash generated from operating activities		(9,746)	31,311
Interest paid		(7,100)	(2,731)
Interest received		151	363
Income tax paid		(11,231)	(15,181)
Net cash flows from operating activities		(27,926)	13,762
Investing activities			
Investment in property, plant and equipment		-	(2,000)
Loan repayment / (issuance)		(26,724)	-
Purchase of intangibles		(36)	(81)
Net cash flows from investing activities		(26,760)	(2,081)
Financing activities			
Proceeds (repayments) on borrowings		66,945	20,474
Repayment of leasing liabilities		(2,832)	-
Dividend distribution		(3,000)	(17,054)
Net cash flows from financing activities		61,113	3,420
Net increase in cash and cash equivalents		6,427	15,101
Cash and cash equivalents, beginning of year		61,511	46,410
Cash and cash equivalents, end of year	25	67,938	61,511

A prior period reclassification adjustment of \$11,914 (in \$000) has been made increasing 'Profit before tax from continuing operations' and decreasing the 'Trade and other payables' line item in the cash flow statement. This amount relates to the 2018 income tax expense and has no effect on the 'Net cash flows from operating activities'. The prior period reclassification adjustment was the result of profit after tax being used in the cash flow instead of profit before tax. No other financial statement disclosures have been affected.

The notes on pages 13 to 43 form an integral part of these financial statements.

NOTES TO THE FINANCIAL STATEMENTS

For the year ended 31 December 2019

1. Corporate Information

These financial statements reflect the financial performance and position of Javelin Global Commodities (UK) Ltd (the 'Company') for the year ended 31 December 2019. The Company is a private company limited by shares incorporated and domiciled in the United Kingdom of Great Britain and Northern Ireland. The registered office is located in London, United Kingdom. The Company was incorporated on 13 March 2015.

The principal activity of the Company is the physical trading and marketing of bulk commodities together with the management of supply chain logistics and operations involved in the movement of physical cargoes. Information on the Company's structure is provided in Note 6. Information on other related party relationships of the Company is provided in Note 30.

Neither the entity owners nor others have powers to amend the financial statements after issue.

2. Basis of preparation

The financial statements of the Company have been prepared in accordance with International Financial Reporting Standards ("IFRS") as issued by the International Accounting Standards Board (IASB) and IFRS Interpretation Committee ("IFRS IC") interpretations, as adopted by the European Union, and with those parts of the Companies Act 2006 applicable to Companies reporting under IFRS.

The financial statements have been prepared on a historical cost basis except for the revaluation of certain financial assets, liabilities and inventories that are measured and revalued at fair value at the end of each reporting period as explained in the accounting policies below. Historical cost is generally based on the fair value of the consideration given in exchange for goods and services.

The financial statements are presented in US Dollars (\$), the functional currency of the Company, and all values are rounded to the nearest thousand (\$000), except when otherwise indicated.

The Company has adopted disclosure exemptions in relation to the following:

- The requirements of IFRS 10 Consolidated Financial Statements. Javelin Global Commodities Holdings LLP, the Company's ultimate parent, produces consolidated financial statements available at its registered address of 7 Howick Place, London, England, SW1P 1BB, United Kingdom.

The Company is exempt from the obligation to prepare consolidated financial statements under Section 400(1) of the Companies Act 2006. The results of the subsidiaries and associated undertakings are dealt within the consolidating financial statements of the ultimate parent, Javelin Global Commodities Holdings LLP.

3. Summary of significant accounting policies

a) Accounting standards adopted

The Company applied IFRS 16 effective 1 January 2019. The nature and effect of the changes as a result of adoption of these new account standards are described below.

The Company has not early adopted any standards, interpretation or amendments that have been issued but are not yet effective, information on these standards is provided in Note 31.

IFRS 16 Leases

IFRS 16 'Leases' replaces IAS 17 'Leases'. The adoption of this new Standard has resulted in the Company recognising a right-of-use asset and related lease liability in connection with all operating leases. The Company previously held no leases and hence there has been no cumulative effect of adopting IFRS 16 being recognised in equity.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

3. Summary of significant accounting policies (continued)

b) Current versus non-current classification

The Company presents assets and liabilities in the statement of financial position based on the current/non-current classification. An asset is current when it is:

- Expected to be realised or intended to be sold or consumed in the normal operating cycle
- Held primarily for the purpose of trading
- Expected to be realised within twelve months after the reporting period or
- Cash or cash equivalent unless restricted from being exchanged or used to settle a liability for at least twelve months after the reporting period

All other assets are classified as non-current.

A liability is current when:

- It is expected to be settled in the normal operating cycle
- It is held primarily for the purpose of trading
- It is due to be settled within twelve months after the reporting period or
- There is no unconditional right to defer the settlement of the liability for at least twelve months after the reporting period

All other liabilities are classified as non-current.

c) Fair value measurement

The Company measures financial instruments such as derivative contracts, at fair value at each reporting date. Fair-value related disclosures for financial instruments that are measured at fair value or where fair values are disclosed are summarised in the following notes:

- Disclosures for valuation methods, significant estimates and assumptions (Note 4)
- Quantitative disclosure of fair value measure hierarchy (Note 7)
- Financial instruments, including those carried at amortised cost (Note 8)

Fair value is the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date. The fair value measurement is based on the presumption that the transaction to sell the asset or transfer the liability takes place either:

- In the principal market for the asset or liability or
- In the absence of a principal market, in the most advantageous market for the asset or liability

The principal or the most advantageous market must be accessible by the Company.

The fair value of an asset or a liability is measured using the assumptions that market participants would use when pricing the asset or liability, assuming that market participants act in their economic best interest.

A fair value measurement of a non-financial asset takes into account a market participant's ability to generate economic benefits by using the asset in its highest and best use or by selling it to another market participant that would use the asset in its highest and best use.

The Company uses valuation techniques that are appropriate in the circumstances and for which sufficient data are available to measure fair value, maximising the use of relevant observable inputs and minimising the use of unobservable inputs.

All assets and liabilities for which fair value is measured or disclosed in the financial statements are categorised within the fair value hierarchy, described as follows, based on the lowest level input that is significant to the fair value measurement as a whole:

- Level 1 — Quoted (unadjusted) market prices in active markets for identical assets or liabilities
- Level 2 — Valuation techniques for which the lowest level input that is significant to the fair value measurement is directly or indirectly observable

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

3. Summary of significant accounting policies (continued)

c) Fair value measurement (continued)

- Level 3 — Valuation techniques for which the lowest level input that is significant to the fair value measurement is unobservable

For assets and liabilities that are recognised in the financial statements at fair value on a recurring basis, the Company determines whether transfers have occurred between levels in the hierarchy by re-assessing categorisation (based on the lowest level input that is significant to the fair value measurement as a whole) at the end of each reporting period.

For the purpose of fair value disclosures, the Company has determined classes of assets and liabilities on the basis of the nature, characteristics and risks of the asset or liability and the level of the fair value hierarchy, as explained above.

The carrying value of cash and cash equivalents, trade and other receivables, and trade and other payables approximate fair value due to the short-term nature of these investments.

d) Revenue from contracts with customers / Revenue recognition

The Company is in the business of the commodity trading in which it earns revenue through the physical delivery of commodity cargoes, marketing services and the fuel management services. Revenue from contracts with customers is recognised when control of the goods or services are transferred to the customer at an amount that reflects the consideration to which the Company expects to be entitled in exchange for those goods or services. The Company has generally concluded that it is principal in its revenue arrangements, except for the agency services below, because the Company controls the goods or services before transferring them to the customer.

Sale of goods and related marketing services

Revenue from the sale of goods is recognised at the point in time when control and risk and rewards of ownership is transferred to the customer, generally on delivery of the goods in accordance with terms. The typical credit terms are three to sixty days.

The Company considers whether there are other obligations in the contract that are separate performance obligations to which a portion of the transaction price needs to be allocated. In determining the transaction price for the sale of goods, the Company considers the effects of variable consideration, the existence of significant financing components, noncash consideration and consideration payable to the customer (if any).

Revenue from marketing services is recognised when control of the services is transferred to the customer at an amount that reflects the consideration to which the Company expects to be entitled in exchange for those services.

Fuel management services

Revenue from fuel management is recognised when control of the services is transferred to the customer at an amount that reflects the consideration to which the Company expects to be entitled in exchange for those services.

Time charter services

Revenue from time charters is recognised when control of the services is transferred to the customer at an amount that reflects the consideration to which the Company expects to be entitled in exchange for those services.

e) Interest

Interest income and expense, including interest income from non-derivative financial assets at fair value through profit or loss, are recognised in comprehensive income, using the effective interest method.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

3. Summary of significant accounting policies (continued)

f) Taxes

Current income tax

Current income tax assets and liabilities are measured at the amount expected to be recovered from or paid to the taxation authorities. The tax rates and tax laws used to compute the amount are those that are enacted or substantively enacted at the reporting date in the countries where the Company operates and generates taxable income.

Current income tax relating to items recognised directly in equity is recognised in equity and not in the statement of comprehensive income. Management periodically evaluates positions taken in the tax returns with respect to situations in which applicable tax regulations are subject to interpretation and establishes provisions where appropriate.

Deferred tax

Deferred tax is provided using the liability method on temporary differences between the tax bases of assets and liabilities and their carrying amounts for financial reporting purposes at the reporting date.

Deferred tax liabilities are recognised for all taxable temporary differences, except:

- When the deferred tax liability arises from the initial recognition of goodwill or an asset or liability in a transaction that is not a business combination and, at the time of the transaction, affects neither the accounting profit nor taxable profit or loss
- In respect of taxable temporary differences associated with investments in subsidiaries, associates and interests in joint arrangements, when the timing of the reversal of the temporary differences can be controlled and it is probable that the temporary differences will not reverse in the foreseeable future

Deferred tax assets are recognised for all deductible temporary differences, the carry forward of unused tax credits and any unused tax losses.

Deferred tax assets are recognised to the extent that it is probable that taxable profit will be available against which the deductible temporary differences, and the carry forward of unused tax credits and unused tax losses can be utilised, except:

- When the deferred tax asset relating to the deductible temporary difference arises from the initial recognition of an asset or liability in a transaction that is not a business combination and, at the time of the transaction, affects neither the accounting profit nor taxable profit or loss
- In respect of deductible temporary differences associated with investments in subsidiaries, associates and interests in joint arrangements, deferred tax assets are recognised only to the extent that it is probable that the temporary differences will reverse in the foreseeable future and taxable profit will be available against which the temporary differences can be utilised

The carrying amount of deferred tax assets is reviewed at each reporting date and reduced to the extent that it is no longer probable that sufficient taxable profit will be available to allow all or part of the deferred tax asset to be utilised. Unrecognised deferred tax assets are re-assessed at each reporting date and are recognised to the extent that it has become probable that future taxable profits will allow the deferred tax asset to be recovered.

Deferred tax assets and liabilities are measured at the tax rates that are expected to apply in the year when the asset is realised, or the liability is settled, based on tax rates (and tax laws) that have been enacted or substantively enacted at the reporting date.

Deferred tax relating to items recognised outside comprehensive income is recognised outside comprehensive income. Deferred tax items are recognised in correlation to the underlying transaction either in other comprehensive income ('OCI') or directly in equity.

Deferred tax assets and deferred tax liabilities are offset if a legally enforceable right exists to set off current tax assets against current tax liabilities and the deferred taxes relate to the same taxable entity and the same taxation authority.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

3. Summary of significant accounting policies (continued)

g) Foreign currencies

Transactions in foreign currencies are initially recorded by the Company at the exchange rate prevalent for the month in which the transaction occurred.

Monetary assets and liabilities denominated in foreign currencies are translated at the functional currency spot rates of exchange at the reporting date.

Differences arising on settlement or translation of monetary items are recognised in the comprehensive income.

Non-monetary items that are measured in terms of historical cost in a foreign currency are translated using the exchange rate prevalent for the month in which the initial transactions occurred. Non-monetary items measured at fair value in a foreign currency are also translated using the exchange rate prevalent for the month in which the fair value is determined. The gain or loss arising on translation of non-monetary items measured at fair value is treated in line with the recognition of the gain or loss on the change in fair value of the item (i.e., translation differences on items whose fair value gain or loss is recognised in OCI or profit and loss are also recognised in OCI or profit and loss, respectively).

h) Property, plant and equipment

Property, plant and equipment are stated at cost, net of accumulated depreciation and accumulated impairment losses, if any. All other repair and maintenance costs are recognised in comprehensive income as incurred.

Depreciation is calculated on a straight-line basis over the estimated useful lives of the assets, as follows:

- Office equipment 1 - 5 years
- Computer equipment 1 - 5 years

An item of property, plant and equipment and any significant part initially recognised is derecognised upon disposal or when no future economic benefits are expected from its use or disposal. Any gain or loss arising on derecognition of the asset (calculated as the difference between the net disposal proceeds and the carrying amount of the asset) is included in the statement of comprehensive income when the asset is derecognised.

The residual values, useful lives and methods of depreciation of property, plant and equipment are reviewed at each financial year end and adjusted prospectively, if appropriate.

i) Leases

For any new contracts entered into on or after 1 January 2019, the Company considers whether a contract is, or contains a lease. A lease is defined as 'a contract, or part of a contract, that conveys the right to use an asset (the underlying asset) for a period of time in exchange for consideration. To apply this definition the Company assesses whether the contract meets three key evaluations which are whether:

- The contract contains an identified asset, which is either explicitly identified in the contract or implicitly specified by being identified at the time the asset is made available to the Company
- The Company has the right to obtain substantially all of the economic benefits from use of the identified asset throughout the period of use, considering its rights within the defined scope of the contract
- the Company has the right to direct the use of the identified asset throughout the period of use. The Company assess whether it has the right to direct 'how and for what purpose' the asset is used throughout the period of use.

Company as a lessee

At lease commencement date, the Company recognises a right-of-use asset and a lease liability on the balance sheet. The right-of-use asset is measured at cost, which is made up of the initial measurement of the lease liability, any initial direct costs incurred by the Company, an estimate of any costs to dismantle and remove the asset at the end of the lease, and any lease payments made in advance of the lease commencement date (net of any incentives received).

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

3. Summary of significant accounting policies (continued)

i) Leases (continued)

The Company depreciates the right-of-use assets on a straight-line basis from the lease commencement date to the earlier of the end of the useful life of the right-of-use asset or the end of the lease term. The Company also assesses the right-of-use asset for impairment when such indicators exist.

At the commencement date, the Company measures the lease liability at the present value of the lease payments unpaid at that date, discounted using the interest rate implicit in the lease if that rate is readily available or the Company's incremental borrowing rate. Lease payments included in the measurement of the lease liability are made up of fixed payments (including in substance fixed), variable payments based on an index or rate, amounts expected to be payable under a residual value guarantee and payments arising from options reasonably certain to be exercised. Subsequent to initial measurement, the liability will be reduced for payments made and increased for interest. It is remeasured to reflect any reassessment or modification, or if there are changes in in-substance fixed payments. When the lease liability is remeasured, the corresponding adjustment is reflected in the right-of-use asset, or profit and loss if the right-of-use asset is already reduced to zero.

The Company has elected to account for short-term leases and leases of low-value assets using the practical expedients. Instead of recognising a right-of-use asset and lease liability, the payments in relation to these are recognised as an expense in profit or loss on a straight-line basis over the lease term. On the statement of financial position, right-of-use assets have been included in property, plant and equipment and lease liabilities have been included in trade and other payables.

j) Intangible assets

The Company made upfront payments to purchase licences and develop trading systems which are measured at cost on initial recognition.

The useful life of intangible assets is assessed as finite.

An intangible asset with finite life is amortised over the useful economic life and assessed for impairment whenever there is an indication that the intangible asset may be impaired. The amortisation period and the amortisation method for an intangible asset with a finite useful life are reviewed at least at the end of each reporting period.

Gains or losses arising from derecognition of an intangible asset are measured as the difference between the net disposal proceeds and the carrying amount of the asset and are recognised in the statement of comprehensive income when the asset is derecognised.

A summary of the policies applied to the Company's intangible assets is, as follows:

	<i>Licenses</i>
Useful lives	Finite Life (5 years)
Amortisation method used	Amortised on straight-line basis over the period of license
Internally generated or acquired	Acquired

k) Financial Instruments

A financial instrument is any contract that gives rise to a financial asset of one entity and a financial liability or equity instrument of another entity.

(i) Financial assets

Initial recognition and measurement

Financial assets are classified at initial recognition and subsequently measured at amortised cost, fair value through other comprehensive income or fair value through profit or loss. The classification of financial assets is determined by the contractual cash flows and where applicable the business model for managing the financial assets. The classification of financial assets at initial recognition depends on the financial asset's contractual cash flow characteristics and the Company's business model for managing them. With the exception of trade receivables that do not contain a significant financing component, the Company initially recognizes the financial asset at its fair value plus, transactions costs. Trade receivables are measured at the transaction price determined under IFRS 15.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

3. Summary of significant accounting policies (continued)

k) Financial Instruments (continued)

(j) Financial assets (continued)

Initial recognition and measurement (continued)

For a financial asset to be classified and measured at amortised cost or fair value through OCI, it needs to give rise to cash flows that are solely payments of principal and interest on the principal amount outstanding.

The Company's business model for managing financial assets refers to how it manages its financial assets in order to generate cash flows. The business model determines whether cash flows will result from collecting contractual cash flows, selling the financial assets, or both.

Purchases and sales of financial assets that require delivery of assets within a time frame established by regulation or convention in the market place are recognised on trade date.

Subsequent measurement

The Company measures financial assets at amortised cost if the financial asset is held within a business model with the objective to hold financial assets to collect contractual cash flows and the contractual terms of the financial asset give rise on specified dates to cash flows that are solely payments of principal and interest on the principal outstanding. Financial assets at amortised cost are subject to impairment. Gains and losses are recognised in profit or loss when the asset is derecognised, modified or impaired. The Company's financial assets at amortised costs are trade receivables.

The Company measures financial assets at fair value through OCI if the financial asset is held within a business model with the objective of both holding to collect contractual cash flows and selling and the contractual terms of the financial asset give rise on specified dates to cash flows that are solely payments of principal and interest on the principal amount outstanding. The Company has no financial assets at fair value through OCI.

The Company measures financial assets at fair value through profit and loss if the financial is held for trading, designated at initial recognition at fair value through profit or loss, or the financial assets mandatorily required to be measured at fair value. Financial asset are classified as held for trading if they are acquired for the purpose of selling or repurchasing in the near term. Financial assets at fair value through profit or loss are carried in the statement of financial position at fair value with net changes in fair value recognised in the statement of profit or loss. The Company's financial assets at fair value through profit or loss are derivative instruments.

Derecognition

A financial asset is primarily derecognised when the rights to receive the cash flows from the asset have expired or the Company has transferred its rights to receive cash flows from the asset or has assumed an obligation to pay the received cash flows in full without material delay to a third under a 'pass-through' arrangement and either the Company has transferred substantially all the risk and rewards of the asset or the Company has neither transferred nor retained substantially all the risk and rewards of the asset but has transferred control of the asset.

Impairment

The Company recognises an allowance for expected credit losses (ECLs). The Company applies a simplified approach in calculating ECLs and recognises a loss allowance based on the expected rate of default at each reporting date as the Company has no historical credit loss experience.

(ii) Financial liabilities

Initial recognition and measurement

Financial liabilities are classified, at initial recognition, as financial liabilities at fair value through profit or loss, loans and borrowings, and payables as appropriate.

All financial liabilities are recognised initially at fair value and, in the case of loans and borrowings and payables, net of directly attributable transaction costs.

The Company's financial liabilities include trade and other payables and derivative financial instruments.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

3. Summary of significant accounting policies (continued)

k) Financial instruments (continued)

(i) Financial liabilities (continued)

Subsequent measurement

Financial liabilities at fair value through profit or loss include financial liabilities held for trading and financial liabilities designated upon initial recognition as at fair value through profit and loss. Financial liabilities are classified as held for trading if they are incurred for the purpose of repurchasing in the near term. The Company's financial liabilities at fair value through profit or loss are derivative financial instruments.

Financial liabilities classified as loans and borrowings or payables are subsequently measured at amortised cost.

Derecognition

A financial liability is derecognised when the obligation under the liability is discharged or cancelled or expires. When an existing financial liability is replaced by another from the same lender on substantially different terms, or terms of an existing liability are substantially modified, such an exchange or modification is treated as the derecognition of the original liability and the recognition of a new liability. The difference in the respective carrying amounts is recognised in the statement of profit or loss.

(iii) Offsetting of financial instruments

Financial assets and financial liabilities are offset and the net amount is reported in the statement of financial position if there is currently enforceable legal right to offset the recognised amounts and there is an intention to settle on a net basis, to realise the assets and settle the liabilities simultaneously.

l) Loans and receivables

Loans and receivables are financial assets with fixed or determinable payments that are not quoted in an active market. Such assets are recognised initially at fair value. Subsequent to initial recognition, loans and receivables are measured at amortised cost using the effective interest method, less any impairment losses. Loan and receivables comprise note receivables and trade and other receivables

m) Derivatives and hedging activities

Derivative instruments, which include physical contracts to sell or purchase commodities that do not meet the own use exemption, are initially recognised at fair value when the Company becomes a party to the contractual provision of the instrument and are subsequently re-measured to fair value at the end of each reporting period. Fair values are determined using quoted market prices, dealer price quotation or using models and other valuation techniques, the key inputs include current market and contractual prices for the underlying instrument time to expiry, yield curves, volatility of the underlying instrument and counterparty risk.

The Company utilises derivative financial instruments to hedge its primary market risk exposures, primarily risk related to commodity price movements. Commodity derivative contracts may be utilised to hedge against commodity price risk for physical purchase and sales contracts, including inventory. Commodity swaps, options and futures are used to manage price and timing risks in conformity with the Company's risk management policies.

Generally, the Company does not apply hedge accounting, but in some instances, it may elect to apply hedge accounting. The Company did not apply hedge accounting in the current year.

n) Commodity contracts

Commodity contracts include forward purchase and sale contracts, options, offtake and marketing agreements. The majority of the Company's commodities contracts form part of the Company's trading activities and are recorded at fair value. Assets are recorded in derivative financial instrument assets, and liabilities are recorded in other derivative financial instrument liabilities. Changes in fair value are recognised in the statement of comprehensive income in cost of sales in the period of change.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

3. Summary of significant accounting policies (continued)

o) Inventories

The Company's inventory consists of commodities held for trading. The Company is a commodity trader and thus the company's inventory is measured at fair value less costs to sell with the change in fair value recognised in cost of sales in the period of the change.

p) Working capital financing

The Company utilises an uncommitted working capital financing facility with various banks. Drawings in the form of loans are provided on a transaction-by-transaction basis against eligible receivable or inventory collateral of which the Company provides a general lien on collateral receivable or inventory to ING. Drawings on the facility are for a tenor of 90 days. Borrowings on the facility are measured at amortised cost.

q) Investment in subsidiaries

Investments in subsidiaries are held at historical cost less any applicable provision for impairment.

r) Cash and short-term investments

Cash and short-term deposits in the statement of financial position comprise cash at banks and in hand and short-term deposits with a maturity of three months or less, which are subject to an insignificant risk of changes in value.

For the purpose of the statement of cash flows, cash and cash equivalents consist of cash and short-term deposits, as defined above as they are considered an integral part of the Company's cash management.

s) Going Concern

As noted in the Director's Report, the directors have a reasonable expectation that the Company has adequate resources to continue in operational existence for the foreseeable future. As such, the directors continue to adopt the going concern basis of accounting in preparing the annual financial statements.

Management has assessed the impact of COVID-19 on the company's ability to operate as a going concern. The company has the financial support from the Group which has sufficient cash and liquidity to fund the Company's operations if necessary. Javelin Global Commodities Holdings LLP has performed stress testing on the combined Javelin Group financial statements which indicates that there is no material risk that the Group will be unable to provide financial support to the Company for a period of at least 12 months from the issuance date of these financial statements. As part of this stress testing, the Group ran a simulation of a worst-case scenario which assumes significant impairments on its current assets and a material reduction in its trading operations. This worst-case scenario demonstrates that the Group would still be able to meet its liabilities as they fall due. In addition, the Company has access to two uncommitted credit facilities with capacity of approximately \$150 million with \$82.4 million of unused spare capacity as of December 31, 2019.

Management deems that with the liquidity available for the Company that it has access to sufficient liquid assets to settle any liabilities as they fall due.

4. Significant accounting judgements, estimates and assumptions

The preparation of the financial statements in conformity with IFRS requires management to make judgements, estimates and assumptions that affect the application of policies and reported amounts of assets and liabilities, income and expenses. The estimates and associated assumptions are based on historical experience and various other factors that are believed to be reasonable under the circumstances, the results of which form the basis of making the judgements about carrying values of assets and liabilities that are not readily apparent from other sources. Actual results may differ from these estimates.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

4. Significant accounting judgements, estimates and assumptions (continued)

Credit and performance risk

The Company's global trading operations expose it to credit and performance risks (e.g. the risk that counterparties fail to sell or purchase physical commodities on agreed terms); these arise particularly in markets demonstrating significant price volatility with limited liquidity and terminal markets and when global and/or regional macroeconomic conditions are weak.

The Company recognises an allowance for expected credit losses (ECLs). The Company applies a simplified approach in calculating ECLs and recognises a loss allowance based on the expected rate of default at each reporting date as the Company has no historical credit loss experience. Continuously, but particularly during such times, judgement is required to determine whether counterparty credit and related expected rate of default and may not be representative of the customer's actual default in the future.

Provisions

The amount recognised as a provision, including tax, legal, contractual and other exposures or obligations, is the best estimate of the consideration required to settle the related liabilities, including any related interest charges, taking into account the risk and uncertainties surrounding the obligation. The Company assesses its liabilities and contingencies based upon the best information available, relevant tax laws and other appropriate requirements.

Valuation of derivative instruments

Derivative instruments are carried at fair value and the Company evaluates the quality and reliability of the assumptions and data used to measure fair value in the three hierarchy levels, Level 1, 2 and 3, as prescribed by IFRS 13 Fair Value Measurement. Fair values are determined in the following ways: externally verified via comparison to quoted market prices in active markets (Level 1); by using models with externally verifiable inputs (Level 2); or by using alternative procedures such as comparison to comparable instruments and/or using models with unobservable market inputs requiring the Company to make market-based assumptions (Level 3). Level 3 inputs therefore include the highest level of estimation uncertainty.

Fair value measurements

In addition to recognising derivative instruments at fair value, as discussed above, an assessment of fair value of assets and liabilities is also required in accounting for other transactions, most notably inventories and disclosures related to fair values of financial assets and liabilities. In such instances, fair value measurements are estimated based on the amounts for which the assets and liabilities could be exchanged at the relevant transaction date or reporting period end and are therefore not necessarily reflective of the likely cash flow upon actual settlements. Where fair value measurements cannot be derived from publicly available information, they are estimated using models and other valuation methods. To the extent possible, the assumptions and inputs used take into account externally verifiable inputs. However, such information is by nature subject to uncertainty, particularly where comparable market-based transactions rarely exist.

Leases

A lessee uses its incremental borrowing rate in measuring a lease liability when the interest rate implicit in the lease cannot be readily calculated. A lessee's incremental borrowing rate is the rate of interest that a lessee would have to pay to borrow over a similar term, and with a similar security, the funds necessary to obtain an asset of a similar value to the right-of-use asset in a similar economic environment. The lessee's incremental borrowing rate is therefore a lease-specific rate. Where an interest borrowing rate cannot be derived from publicly available information, they are estimated using other valuation methods. To the extent possible, the assumptions and inputs used consider externally verifiable inputs. However, such information is by nature subject to uncertainty, particularly where comparable borrowing rates rarely exist.

When the entity has the option to extend a lease, management used its judgement to determine whether an option would be reasonably certain to be exercised. Management considers all facts and circumstances including their past practice and any cost that will be incurred to change the asset if an option to extend is not taken, to help them determine the lease term.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)

For the year ended 31 December 2019

5. Capital management

For the purpose of the Company's capital management, capital includes issued capital and all other equity reserves attributable to the equity holders of the Company. The overriding objectives of the Company's capital management policies are to safeguard and support the business as a going concern and to maintain optimal capital structure with a view to maximising returns to the shareholder and benefits to other stakeholders by reducing the Company's cost of capital.

6. Group company information

Information about direct subsidiaries

Subsidiary Name	Principal Activities	Country of Incorporation	% Equity Interest
Javelin Global Commodities (CH) GmbH	Marketing	Switzerland	100
Javelin Global Commodities (SG) Pte. Ltd	Marketing	Singapore	100
Javelin Global Commodities (IL) Ltd	Marketing	Israel	100
Blackjewel Marketing & Sales (UK) Ltd	Holding Company	United Kingdom	100

Information about the holding company

The holding company of the Company is Javelin Global Commodities Services Ltd which is incorporated in the United Kingdom.

Information about the ultimate holding company

The ultimate holding company of the Company is Javelin Global Commodities Holdings LLP which is registered in the United Kingdom.

7. Fair value measurement

The Company classifies the fair values of its financial instruments into a three-level hierarchy based on the degree of the source and observability of the inputs that are used to derive the fair value of the financial asset or liability as follows:

- Level 1 — Quoted (unadjusted) market prices in active markets for identical assets or liabilities
- Level 2 — Valuation techniques for which the lowest level input that is significant to the fair value measurement is directly or indirectly observable
- Level 3 — Valuation techniques for which the lowest level input that is significant to the fair value measurement is unobservable

Level 1 classifications primarily include futures, swaps and options. Level 2 classifications primarily include physical forward transactions which derive their fair value primarily from exchange quotes, observable broker quotes and applicable market-based estimates surrounding location and quality.

The following tables provide the fair value measurement hierarchy of the Company's net financial asset and liability commodity trading positions for which fair value is measured on a recurring basis as of December 2019 and 2018. Other assets which are measured at fair value on a recurring basis are inventories. Refer to Note 22 for disclosures in connection with the inventories fair value measurement.

Financial assets

	2019			
<i>Current derivative financial assets</i>				
	Total (\$'000)	Level 1 (\$'000)	Level 2 (\$'000)	Level 3 (\$'000)
Commodity futures, swaps and options – Group entities				
Commodity futures, swaps and options – non Group entities	9,709	9,709	-	-
Physical commodity forwards – Group entities	6,451	-	6,451	-
Physical commodity forwards – non Group entities	45,576	-	45,576	-
Total current financial assets	61,736	9,709	52,027	-

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

7. Fair value measurement (continued)

Financial assets (continued)

Non-current derivative financial assets

	Total (\$'000)	Level 1 (\$'000)	Level 2 (\$'000)	Level 3 (\$'000)
Commodity futures, swaps and options – Group entities	-	-	-	-
Commodity futures, swaps and options – non Group entities	-	-	-	-
Physical commodity forwards – Group entities	-	-	-	-
Physical commodity forwards – non Group entities	39,393	-	39,393	-
Total non-current financial assets	39,393	-	39,393	-
Total financial assets	101,129	9,709	91,420	-

2018

Current derivative financial assets

	Total (\$'000)	Level 1 (\$'000)	Level 2 (\$'000)	Level 3 (\$'000)
Commodity futures, swaps and options – Group entities	51,684	51,684	-	-
Commodity futures, swaps and options – non Group entities	6,001	6,001	-	-
Physical commodity forwards	60,817	-	60,817	-
Total current financial assets	118,502	57,685	60,817	-

Non-current derivative financial assets

	Total (\$'000)	Level 1 (\$'000)	Level 2 (\$'000)	Level 3 (\$'000)
Commodity futures, swaps and options – Group entities	-	-	-	-
Commodity futures, swaps and options – non Group entities	-	-	-	-
Physical commodity forwards	6,827	-	6,827	-
Total non-current financial assets	6,827	-	6,827	-
Total financial assets	125,329	57,685	67,644	-

Financial liabilities

2019

Current derivative financial liabilities

	Total (\$'000)	Level 1 (\$'000)	Level 2 (\$'000)	Level 3 (\$'000)
Commodity futures, swaps and options – Group entities	-	-	-	-
Commodity futures, swaps and options – non Group entities	1,790	1,790	-	-
Physical commodity forwards – Group entities	422	-	422	-
Physical commodity forwards – non Group entities	18,858	-	18,858	-
Total current financial liabilities	21,070	1,790	19,280	-

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

7. Fair value measurement (continued)

Financial liabilities (continued)

Non-current derivative financial liabilities

	Total	Level 1	Level 2	Level 3
	(\$'000)	(\$'000)	(\$'000)	(\$'000)
Commodity futures, swaps and options – Group entities	-	-	-	-
Commodity futures, swaps and options – non Group entities	747	747	-	-
Physical commodity forwards – Group entities	-	-	-	-
Physical commodity forwards – non Group entities	4,766	-	4,766	-
Total non-current financial liabilities	5,513	747	4,766	-
Total financial liabilities	26,583	2,537	24,046	-

2018

Current derivative financial liabilities

	Total	Level 1	Level 2	Level 3
	(\$'000)	(\$'000)	(\$'000)	(\$'000)
Commodity futures, swaps and options – Group entities	2,001	2,001	-	-
Commodity futures, swaps and options – non Group entities	6,623	6,623	-	-
Physical commodity forwards	34,531	-	34,531	-
Total current financial liabilities	43,155	8,624	34,531	-

Non-current derivative financial liabilities

	Total	Level 1	Level 2	Level 3
	(\$'000)	(\$'000)	(\$'000)	(\$'000)
Commodity futures, swaps and options – Group entities	465	465	-	-
Commodity futures, swaps and options – non Group entities	-	-	-	-
Physical commodity forwards	1,273	-	1,273	-
Total financial liabilities	1,738	465	1,273	-
Total non-current financial liabilities	44,893	9,089	35,804	-

There were no transfers between the fair value hierarchy levels during 2018.

Financial instruments for which carrying value approximates fair value

The carrying amount of cash and cash equivalents, other receivables and payables and short and long-term borrowings approximates their fair values due to the relatively short-term maturity of these financial instruments.

8. Financial assets and financial liabilities

The following table presents the carrying values and fair values of the Company's financial instruments. Fair value is the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction in the principal (most advantageous) market at the measurement date under current market conditions. Where available, market values have been used to determine fair values. When market values are not available, the estimated fair values have been determined using market information and appropriate valuation methodologies but are not necessarily indicative of the amounts the Company could realise in the normal course of business.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

8. Financial assets and financial liabilities (continued)

The financial assets and liabilities are presented by class in the table below at their carrying values, which generally approximate the fair values.

			2019
	Amortised Cost	FVtPL ¹	Total
Assets			
Non-current financial derivative instruments	-	39,393	39,393
Current financial derivative instruments	-	61,736	61,736
Current note receivable	40,734	-	40,734
Trade and other receivables	108,058	-	108,058
Cash and short-term deposits	67,938	-	67,938
Total financial assets	216,730	101,129	317,859
Liabilities			
Non-current financial derivative instruments	-	5,513	5,513
Current financial derivative instruments	-	21,070	21,070
Other non-current liabilities	50,814	-	50,814
Other current liabilities	18,764	-	18,764
Non-current loans and borrowings	22,875	-	22,875
Current loans and borrowings	117,439	-	117,439
Trade and other payables	63,924	-	63,924
Total financial liabilities	273,816	26,583	300,399

			2018
	Amortised Cost	FVtPL ¹	Total
Assets			
Non-current financial derivative instruments	-	6,827	6,827
Current financial derivative instruments	-	118,501	118,501
Current note receivable	14,010	-	14,010
Trade and other receivables	106,943	-	106,943
Cash and short-term deposits	61,511	-	61,511
Total financial assets	182,464	125,328	307,792
Liabilities			
Non-current financial derivative instruments	-	1,738	1,738
Current financial derivative instruments	-	43,155	43,155
Other current liabilities	12,523	-	12,523
Loans and borrowings	73,369	-	73,369
Trade and other payables	188,577	-	188,577
Total financial liabilities	274,469	44,893	319,362

¹ FVtPL is fair value through profit and loss.

Financial assets and financial liabilities are recognised in the statement of financial position when the Company becomes a party to the contractual provisions of the instruments. Financial assets are derecognised when the Company no longer has the rights to the cash flows and or the risks and rewards of ownership of control of the asset. Financial liabilities are derecognised when the obligation under the liability is discharged, cancelled or expired.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

8. Financial assets and financial liabilities (continued)

The following tables shows the amounts recognised for financial assets and liabilities which are subject to offsetting arrangements on a gross basis, and the amounts offset in the consolidated balance sheet.

			2019 \$'000
	Gross amounts recognised financial assets (liabilities)	Amounts set off	Net amounts presents on the statement of financial position
Financial derivative assets	101,128	-	101,128
Financial derivative liabilities	26,583	-	26,583

			2018 \$'000
	Gross amounts recognised financial assets (liabilities)	Amounts set off	Net amounts presents on the statement of financial position
Financial derivative assets	126,637	(1,309)	125,328
Financial derivative liabilities	(46,202)	1,309	(44,893)

Unrealised gains and losses recognised during the year in the Company's profit and loss through cost of sales is as follows:

	2019 \$'000
Commodity futures, swaps and options – realised	162,437
Commodity futures, swaps and options – unrealised	(34,783)
Physical commodity forwards - unrealised	24,297

RISK MANAGEMENT OBJECTIVES

The Company manages its financial risks through risk management at the Group level. Senior management identifies and evaluates financial risks on an on-going basis. The principal risks to which the Company is exposed include market risk, credit risk and liquidity risk.

Market risk

Market risk is defined as the risk that the fair value or future cash flows of a financial instrument will fluctuate because of changes in market prices. The Company's market risks arise from open positions in (a) commodities and commodity derivatives and (b) non-USD denominated assets and liabilities, to the extent that these are exposed to general and specific market movements.

Commodities price risk

As a result of the core operations the Company is exposed to commodities price risk. The Company monitors commodities price risk through industry standard risk metrics such as value-at-risk (VaR) and stress testing.

Commodity price sensitivity

Value-at-risk ("VAR") calculated using the variance-covariance method at a 95% confidence level based on one-year historical returns was \$902 (in \$000) as of 31 December 2019.

Foreign currency risk

The Company's trading business is generally denominated in USD therefore exposure to exchange rate fluctuations is not significant.

Interest rate risk

The Company is exposed to interest rate risk through its working capital financing facility. The working capital financing facility is short-term and interest rate risk is not deemed significant.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

8. Financial assets and financial liabilities (continued)

Credit risk

Credit risk is the risk that a counterparty will not meet its obligations under a financial instrument or customer contract, leading to financial loss. The Company is exposed to credit risks from its operating activities (primarily trade receivables). Credit risk is analysed through our credit analysis procedures and managed by our management board.

The maximum exposure to credit risk before the consideration of collateral or other credit enhancements received for receivables and other financial assets is represented by their carrying amount. The Group obtains guarantees, collaterals and other credit enhancements to manage, reduce or minimise credit risk. As at 31 December 2019, the value of such collateral and credit enhancements, including guarantees and letters of credit was \$17.36 and \$16.41M, respectively. (2018: \$1.25M and \$0.0M).

The maximum exposure to credit risk at 31 December was:

	2019	2018
	\$'000	\$'000
Trade and other receivables due from third parties	89,661	85,747
Trade and other receivables due from related parties	4,465	13,435
Receivables due from Group companies	16,489	7,760
Tax receivable	166	195
Financial instruments	101,128	125,328
Note receivable	40,961	14,010
Other assets	10,692	11,852
Cash and cash equivalents	67,938	61,511
Total exposure	<u>331,500</u>	<u>319,838</u>
Expected credit loss	<u>(2,784)</u>	<u>(1,265)</u>
Net exposure	<u>328,716</u>	<u>318,573</u>

The Company recognises an allowance for expected credit losses (ECLs). The Company applies a simplified approach in calculating ECLs and recognises a loss allowances based on the expected rate of default at each reporting date as the Company has no historical credit loss experience. The expected rate of default is determine based on counterparty credit rating. Financial assets are written off when the Company has no reasonable expectation of recovering amounts due.

The aging of trade and other receivables at 31 December 2019 and 2018 was:

	2019	2018
	\$'000	\$'000
More than 90 days	10,487	3,402
Between 31-90 days	2,674	1,534
Between 1-30 days	16,749	21,165
Not yet due	80,705	81,036
	<u>110,615</u>	<u>107,137</u>

The internal assessed rate of default of trade and other receivables at 31 December 2019 and 2018 was:

	2019	2018
	\$'000	\$'000
<1%	60,934	57,903
>1% and <5%	26,155	41,474
>5%	7,037	-
Group	<u>16,489</u>	<u>7,760</u>
	<u>110,615</u>	<u>107,137</u>

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)**For the year ended 31 December 2019****8. Financial assets and financial liabilities (continued)****Liquidity Risk**

Liquidity risk is the risk that the Company may encounter difficulty in meeting its obligations associated with financial liabilities that are settled by delivering cash or other financial assets.

The Company seeks to manage its liquidity risk by ensuring that sufficient liquidity is available to meet its foreseeable needs. The maturity profile for the Company's financial liabilities at 31 December 2018 based on contractual undiscounted payments is analysed as follows:

	Total	< 3	3–12	1–2	2–5	> 5
	(\$'000)	months	months	years	years	years
		(\$'000)	(\$'000)	(\$'000)	(\$'000)	(\$'000)
Financial derivative instruments	2,537	1,063	727	747	-	-
Physical derivative instruments	24,046	15,384	3,895	1,896	2,871	-
Trade and other payables	63,924	63,924	-	-	-	-
Other liabilities	69,578	5,361	13,403	18,534	32,280	-
Loan and borrowings	140,314	104,014	13,425	13,452	9,423	-
Total	300,399	189,746	31,450	34,629	44,574	-

9. Revenue from contracts with customers / revenue

Set-out below is the Company's revenue from contracts with customers:

	2019	2018
	\$'000	\$'000
Commodity sales and related marketing services	1,466,925	2,007,709
Time chartering services	1,183	-
Fuel management services	1,250	571
	1,469,358	2,008,280

Commodity sales in the statement are derived from physical trading and marketing of bulk commodities. Marketing income is derived from the commission earned under the coal sales contract agreed with the principal provider. Fuel management services are derived through services provided for management of coal supply to power plants.

Set-out below is the disaggregation of the Company's revenue from contracts with customers:

	2019	2018
	\$'000	\$'000
Type of good or service		
Commodity sales and related marketing services – coal	1,461,474	1,986,346
Commodity sales – steel scrap	2,420	20,425
Commodity sales – other	3,031	938
Time chartering services	1,183	-
Fuel management services	1,250	571
Total revenue from contracts with customers	1,469,358	2,008,280
Geographical markets		
North America	245,155	196,891
South America	219,179	255,915
Europe	327,807	821,775
Asia	579,189	546,400
Africa	98,028	187,299
Total revenue from contracts with customers	1,469,358	2,008,280

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)**For the year ended 31 December 2019****9. Revenue from contracts with customers / revenue (continued)***Contract balances*

	2019	2018
	\$'000	\$'000
Trade receivables	108,058	105,677
Contract assets	-	-
Contract liabilities	1,034	10,955

Trade receivables are non-interest bearing and are generally on terms of 3 to 60 days. In 2019, \$2.6M (2018: \$1.3M) was recognised as provision for expected credit losses on trade receivables. Contract liabilities include prepayments received on shipments to be delivered.

*Performance obligations**Commodity sales and marketing services.*

The Company sells commodities as principal under Inco terms of FOB, DES and CIF with payment terms of 3 to 60 days from date of invoice. For FOB and DES sales, the Company's performance obligation is satisfied upon delivery of the commodity at designated load port and disport, respectively. For CIF sales, the Company's performance obligation to the deliver the goods is satisfied upon delivery of the commodity at the designated load port, however, the service component of the contract, handling the shipping from designated load port to disport, is satisfied over the shipment period; transit days. For marketing services Company's performance obligation is satisfied upon purchase and receipt of delivery of the commodity goods subject to marketing agreements.

	2019	2018
	\$'000	\$'000
Within one year	690	646

Fuel management services

The Company's performance is satisfied over the period of the time in which the service is provided.

Time chartering services

The Company's performance is satisfied over the period of the time in which the service is provided.

	2019	2018
	\$'000	\$'000
Within one year	344	-

10. Cost of sales

Cost of sales recognised in the statement of comprehensive income is analysed as follows:

	2019	2018
	\$'000	\$'000
Commodity trading costs	1,400,473	1,907,130
Trading fees	385	1,056
	<u>1,400,858</u>	<u>1,908,186</u>

Commodity trading costs in the statement are derived from physical and financial trading of bulk commodities.

Trading fees represent broker, clearing and exchange fees and commissions and are derived from executed physical and financial trades. Included within Cost of Sales is an \$8.2 million inventory write-down due to quality issues. The Company is exploring its options to recover this amount from certain counterparties but deems it highly unlikely in current market conditions.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

11. Administrative expenses and impairment losses

Administrative expenses recognised in the statement of comprehensive income is analysed as follows:

	2019	2018
	\$'000	\$'000
Salary and benefits	4,415	4,981
Depreciation & amortisation	163	241
Legal fees	-	548
Advisory and consulting fees	433	109
Subscription fees	1,118	506
Foreign exchange loss / (gain)	102	844
Other miscellaneous selling, general and administrative costs	1,248	1,473
Intercompany expense	22,111	24,971
	<u>29,590</u>	<u>33,673</u>

Impairment losses recognised in the consolidated statement of comprehensive income is as follows:

	2019	2018
	\$'000	\$'000
Impairment	8,785	-
	<u>8,785</u>	<u>-</u>

Included within impairment is an \$1.2 million promissory note write-down due to non-performance of payment obligations. The Company is exploring its options to recover this amount from certain counterparties but deems it highly unlikely in current market conditions.

Subsequent to year end, Murray Metallurgical Coal Holdings LLC and Foresight Energy LP filed for Chapter 11 bankruptcy in the United States. As part of the bankruptcy negotiations, the Company mutually agreed to reduce the prepetition obligations by \$6.3 million and \$1.2 million, respectively. More details on events subsequent to 31 December 2019 are included at Note 32.

12. Other Income

	2019	2018
	\$'000	\$'000
Loss of sale on asset	-	204
Rendering of services to Group entities	379	-
Gain on purchase of assets	7,571	-
	<u>7,950</u>	<u>204</u>

13. Finance Cost

	2019	2018
	\$'000	\$'000
Interest on credit facility from immediate parent	895	-
Interest on credit facility from related party	2,442	2,663
Interest on financing facility from third party	2,346	1,135
Interest on borrowings	2,349	-
Interest expense for leasing arrangement	373	-
	<u>8,405</u>	<u>3,798</u>

Finance costs include the interest expensed as part of the time charter lease liability. The Company's incremental borrowing rate is the rate of interest that the Company would have to pay to borrow over a similar term, and with a similar security, the funds necessary to obtain an asset of a similar value to the right-of-use asset in a similar economic environment. The Company has deemed the rate for this lease to be 4.7%.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

14. Finance Income

	2019	2018
	\$'000	\$'000
Interest on working capital financing facility	3,453	997
Interest on promissory notes	807	330
Interest on credit facility to Group entities	629	-
Interest on advance	902	565
Interest on margin facility	129	97
	<u>5,920</u>	<u>1,989</u>

15. Staff costs

	2019	2018
	\$'000	\$'000
Wages, salaries and discretionary bonus	3,939	4,644
Social security costs	297	212
Other pension costs	179	125
Total staff costs	<u>4,415</u>	<u>4,981</u>

Director's remuneration paid by Javelin Global Commodities Services Ltd. in respect of qualifying services:

	2019	2018
	\$'000	\$'000
In respect of the highest paid director:		
Aggregate remuneration	<u>2,174</u>	<u>3,572</u>
Total director's remuneration	<u>2,174</u>	<u>3,572</u>
Number of persons employed as of 31 December 2019		14
Number of persons employed as of 31 December 2018		12

16. Auditor's remuneration

The Company incurred the following amounts in respect of the audit of the financial statements and for other services provided to the Company for the year ended 31 December:

	2019	2018
	\$'000	\$'000
Audit of the financial statements	351	182
Taxation compliance services	<u>324</u>	<u>136</u>
	<u>675</u>	<u>318</u>

Auditors' remuneration and tax compliance services for the entity are paid by a Javelin Global Commodities Services Limited and are recharged through an intercompany arrangement.

17. Income tax

The major components of the income tax expense for the year ended 31 December 2019 and 2018 are:

	2019	2018
	\$'000	\$'000
<i>Current year tax expense</i>		
Current year income tax charge	6,983	12,238
Adjustment for prior year	<u>5</u>	<u>(324)</u>
Income tax expense reported in the statement of comprehensive income	<u>6,988</u>	<u>11,914</u>

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)**For the year ended 31 December 2019****17. Income tax (continued)**

Reconciliation of tax expense and the accounting profit multiplied by the UK's domestic tax rate for 2019 and 2018:

	2019	2018
	\$'000	\$'000
Accounting profit before income tax	35,590	64,408
At the UK's statutory income tax rate ²	6,762	12,238
Adjustment for non-deductible expenses	4	5
Adjustment for prior year change in estimates	5	(324)
Other adjustments	217	(5)
Income tax expense reported in the statement of comprehensive income	<u>6,988</u>	<u>11,914</u>

² Income tax calculated basis UK statutory tax rate of 19%.

18. Property, plant and equipment

	Other Equipment \$'000	Computer Equipment \$'000	Time Charters - Right-of- Use Asset (Note 20) \$'000	Total \$'000
Cost				
At 31 December 2017	435	167	-	602
Additions	-	-	2,000	2,000
Disposals	(435)	(167)	-	(602)
At 31 December 2018	-	-	2,000	2,000
Additions	-	-	71,005	71,005
Disposals	-	-	-	-
At 31 December 2019	-	-	73,005	73,005
Depreciation				
At 31 December 2017	196	112	-	308
Depreciation	55	35	-	90
Disposals	(251)	(147)	-	(398)
At 31 December 2018	-	-	-	-
Depreciation	-	-	1,761	1,761
Disposals	-	-	-	-
At 31 December 2019	-	-	1,761	1,761
Net Book Value				
At 31 December 2019	-	-	71,244	71,244
At 31 December 2018	-	-	2,000	2,000
At 31 December 2017	239	55	-	294

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

19. Intangible assets

	Licenses with definite useful life \$'000	Total \$'000
Cost		
At 31 December 2017	1,239	1,239
Additions	81	81
Disposals	-	-
At 31 December 2018	1,320	1,320
Additions	35	36
Disposals	-	-
At 31 December 2019	1,355	1,356
Depreciation		
At 31 December 2017	364	364
Depreciation	151	151
Disposals	-	-
At 31 December 2018	515	515
Depreciation	163	163
Disposals	-	-
At 31 December 2019	678	678
Net Book Value		
At 31 December 2019	677	677
At 31 December 2018	805	805
At 31 December 2017	875	875

20. Leases

The Company has leases for three-time charters. With the exception of short-term leases and leases of low-value underlying assets, each lease is reflected on the balance sheet as a right-of-use asset and a lease liability. Variable lease payments which do not depend on an index or a rate are excluded from the initial measurement of the lease liability and asset. The Company classifies its right-of-use assets in a consistent manner to its property, plant and equipment (see Note 18).

Right-of-use- asset	Number of right-of-use assets leased	Average remaining lease term	Number of leases with extension option	Number of leases with a termination option
Time charters	3	3.5 years	2	-

Right-of-use-assets

Additional information on the right-of-use-assets by class of assets is as follows:

Right-of-use- asset	Carrying amount	Additions	Depreciation	Total
Time charters	73,005	-	(1,761)	71,244

The right-of-use assets are included in the same line item as where the corresponding underlying assets would be presented if they were owned.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

20. Leases (continued)

Lease liabilities

Set out below are the carrying amounts of lease liabilities (included under Other Liabilities) and the movements during the period:

	2019
	\$'000
As at 1 January 2019	-
Additions	70,004
Accretion of interest	373
Payments	(1,832)
As at 31 December 2019	68,545

Lease liabilities are presented in the statement of financial position as follows:

	2019
	\$'000
<i>Current</i>	17,731
<i>Non-current</i>	50,814
	68,545

Additional information on the lease liabilities and amounts in respect of possible future lease termination options not recognised as a liability are as follows:

Right-of-use-asset	Lease liability	Lease termination options recognised as part of the lease liability	Number of leases with an extension option that is not considered reasonably certain of exercise	Additional lease liabilities that would be incurred were it to become reasonably certain that the extension option would be exercised
Time charters	68,545	-	2	19,897

The use of extension and termination options gives the Company added flexibility in the event it has identified more suitable assets in terms of cost and/or location or determined that it is advantageous to remain in a location beyond the original lease term. An option is only exercised when consistent with the Company's strategy and the economic benefits of exercising the option exceeds the expected overall cost.

The following are the amounts recognised in the Statement of Comprehensive Income:

	2019
	\$'000
Depreciation expense of office right-of-use asset (cost of sales)	1,761
Interest expense on lease liabilities (finance cost)	373
Total amount recognised in Statement of Comprehensive Income	2,134

The Company had total cash outflows of \$2,832 (in '000) in 2019. This also includes amount paid for assets acquired before commencement of lease. The Company also had a net non-cash addition to the right of use assets of \$2,000 (in '000).

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

21. Investment in subsidiaries

	\$'000
At 31 December 2017	56
Additions	-
At 31 December 2018	56
Additions	-
At 31 December 2019	56

On 4 December 2017 the Company acquired 100% of the voting shares of Blackjewel Marketing and Sales (UK) Ltd, a private company based in the United Kingdom. Blackjewel Marketing and Sales (UK) Ltd was acquired for consideration of GBP 100. Blackjewel Marketing and Sales (UK) Ltd previously had a 40.00% profit share interest in Blackjewel Marketing and Sales Holdings LLC, a limited liability company based in the United States and is designated the manager of the entity.

On 18 October 2018, Blackjewel Marketing and Sales Holdings LLC redeemed its ownership interest held by Blackjewel Marketing and Sales (UK) Ltd as well as the ownership interest held by the other two partners. Subsequent to the redemption, Blackjewel Marketing and Sales Holding LLC reorganized as Blackjewel Marketing and Sales Holding LP. Javelin Global Commodities (US) LP, a wholly-owned subsidiary of the Partnership, acquired a 40.00% ownership in exchange for the performance of marketing and management services.

On 20 November 2015 the Company acquired 100% of the voting shares of Javelin Global Commodities (SG) Pte Ltd, a private company based in Singapore. Javelin Global Commodities (SG) Pte Ltd was acquired for consideration of 1 SGD. Subsequently, Javelin Global Commodities (SG) Pte Ltd issued 50,000 shares at 1 SGD, of which the Company acquired for total consideration of SGD 50,000.

On 2 October 2015 the Company acquired 100% of the voting shares of Javelin Global Commodities (CH) GmbH, a private company based in Switzerland. Javelin Global Commodities (CH) GmbH was acquired for consideration of CHF 20,000.

On 30 August 2015 the Company acquired 100% of the voting shares of Javelin Global Commodities (IL) Ltd, a private company based in Israel. Javelin Global Commodities (IL) Limited was acquired at nil par value.

22. Inventories

Inventories consist of the following:

	2019	2018
	\$'000	\$'000
Stock in trade in stockpile	67,497	85,083
Stock in trade in transit	4,624	62,571
	<u>72,121</u>	<u>147,654</u>

Fair value of inventories is a Level 2 fair value measurement using observable market prices obtained from exchanges, traded reference indices or market survey services adjusted for relevant location and quality differentials. There are no significant unobservable inputs in the fair value measurement of inventories.

In 2019 and 2018, \$39.6 million and \$29.2 million of the Company's inventories are financed through the Company's working capital financing facilities with various banks, respectively.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

23. Trade and other receivables

Trade and other receivables consist of the following:

	2019 \$'000	2018 \$'000
Commodity accounts receivable	90,384	95,376
Commissions accounts receivable	880	3,532
Receivables from Group companies	16,489	7,760
Other receivables	305	274
	<u>108,058</u>	<u>106,942</u>

In 2019, \$27.8 million (2018: \$16.7 million) of the Company's commodity accounts receivable are financed through the Company's working capital financing facilities with various banks.

Set out below is the movement in the allowance for expected credit losses of trades receivables:

	2019 \$'000	2018 \$'000
As at 1 January	1,265	3,000
Adjustment on 1 January	-	665
Provision for expected credit losses	2,558	600
Recovery	(1,265)	(3,000)
	<u>2,558</u>	<u>1,265</u>

24. Note receivables

Note receivables consist of the following:

	2019 \$'000	2018 \$'000
<i>Current</i>		
Promissory note	9,470	2,250
Receivables financing arrangement	5,000	11,760
	<u>14,470</u>	<u>14,010</u>
<i>Non-current</i>		
Promissory note	-	-
	<u>-</u>	<u>-</u>

Promissory Notes

On 1 August 2017, the Company entered in to a \$2.25 million promissory note with Quinsam Coal Corporation ('Quinsam'). In June 2019, the Company restructured this obligation plus certain amounts due to a shareholder at Quinsam in the form of a new secured promissory note. Upon entering the note, all prior agreements were deemed terminated and obligations were deemed satisfied and discharged. As of 31 December 2019, there were borrowings of \$7.1 million on the arrangement.

On 4 February 2019, the Company entered in to a secured \$2.3 million promissory note with another individual. As of 31 December 2019, there were borrowings of \$2.3 million on the arrangement.

Receivables Financing

In December 2017, the Company entered into a receivables financing arrangement with Bluestone Coal Sales Corporation by which the Company purchases certain receivables from Justice. As of 31 December 2019 and 2018, there were borrowings of \$5.0 million and \$11.7 million on the arrangement, respectively.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

25. Cash and short-term deposits

	2019	2018
	\$'000	\$'000
Cash at banks and on hand	67,938	61,511
	<u>67,938</u>	<u>61,511</u>

26. Issued capital and reserves

Share capital includes total nominal proceeds of \$10,000,000 on the issue of the Company's equity share capital comprising of 6,870,350 fully paid Ordinary shares at the value of £1/share on 9 June 2016 and total nominal proceeds of \$155 on the issue of the Company's equity share capital comprising of 100 fully paid Ordinary shares at the value of £1/share on incorporation on 13 March 2015. In each instance, the equity shares were issued to the Company's parent, Javelin Global Commodities Services Ltd. Javelin Global Commodities Services Ltd owns 100% of the voting shares issued by the Company

Authorised

	\$'000	\$'000
	2019	2018
Ordinary share capital (6,870,450 ordinary shares)	10,000	10,000

	Shares	\$'000
<i>Ordinary shares issued and fully paid</i>		
At 31 December 2017	6,870,450	10,000
Share issuance	-	-
At 31 December 2018	<u>6,870,450</u>	<u>10,000</u>
Share issuance	-	-
At 31 December 2019	<u>6,870,450</u>	<u>10,000</u>

	\$'000
<i>Retained earnings</i>	
At 31 December 2017	104,362
Profit for the year	52,494
Distribution to shareholder	<u>(27,205)</u>
At 31 December 2018	<u>129,651</u>
Profit for the year	28,602
Distribution to shareholders	<u>(3,000)</u>
At 31 December 2019	<u>155,253</u>

27. Trade and other payables

	2019	2018
	\$'000	\$'000
<i>Current</i>		
Commodity accounts payable	56,839	164,795
Payables due to Group companies	4,601	23,782
Other payables	<u>9,648</u>	<u>1,832</u>
	<u>71,088</u>	<u>190,409</u>
Deferred revenue	1,033	10,955
	<u>72,121</u>	<u>201,364</u>

The carrying value of trade and other payables approximates its fair value.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

28. Loan and borrowing obligations

	2019	2018
	\$'000	\$'000
<i>Current</i>		
Loan and borrowings from Group entities	32,048	27,467
Loan and borrowings from third parties	18,012	-
Working capital financing facility	67,379	45,902
	<u>117,439</u>	<u>73,369</u>
<i>Non-current</i>		
Loan and borrowings from third parties	22,875	-

The intercompany loan and borrowings is a revolver facility of \$35.0 million and bears an interest rate of 3.00% per annum.

The Company has an uncommitted working capital financing facility with various banks with a total capacity of up to \$150.0 million. The transactional based facilities are subject to approval by the bank on a transaction-by-transaction basis with advance rates dependent on the type and location of collateral. As at 31 December 2019, \$39.6 million of the financing drawn on the facility is collateralized by commodity stock inventory and \$27.8 million is collateralized by receivables.

On 30 May 2019, the Company entered into a \$25 million advance payment arrangement with a Europe based customer. This advance matures in March 2024. As at 31 December 2019, \$22 million remained of the advance.

On 28 May 2019, the Company entered into a \$25 million advance payment arrangement with an Asia based customer. This advance matures in March 2022. As at 31 December 2019, \$17.9 million remained of the advance.

29. Commitments and contingencies

At 31 December 2019, the Company had nil commitments or contingent liabilities.

30. Related party disclosures

On 29th October 2019, Murray Energy Corporation, who holds a 34% ownership in the Parent and is a producer for the Company's sales contracts, filed for Chapter 11 bankruptcy protection in the United States. Murray Energy Corporation have continued to operate through the bankruptcy proceedings and the court monitored restructuring. As part of the bankruptcy process, a revised marketing agreement was approved by the Court on substantially similar terms as the previous agreements. It is expected that the revised marketing agreement will be assumed and assigned to the entity that emerges from bankruptcy. As such, there is no immediate financial impact of the bankruptcy filing on the Company or Group. The Group will continue to evaluate the financial statement impact, if any, throughout Murray Energy Corporation's bankruptcy proceedings.

Note 6 provides information the Company's structure, including details of the subsidiaries and the holding company. Parties are considered to be related if one party has the ability to control the other party or exercise significant influence over the party in making financial or operational decisions. Related parties represent associated companies, shareholders, directors and key management personnel of the Company of which they are principal owners. In the normal course of business, the Company enters into various arm's length transactions with related parties. The following table presents the Company's identified related parties.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)**For the year ended 31 December 2019****30. Related party disclosures (continued)**

Name of related party	Relationship
Murray Energy Corporation and affiliates	Parent of Murray Global Commodities, Inc.
Murray Global Commodities, Inc.	34% ownership interest in Ultimate Parent
Uniper SE	Parent of Uniper Global Commodities SE
Uniper Global Commodities SE	28% ownership interest in Ultimate Parent
Javelin Management Services LLP	38% ownership interest in Ultimate Parent
Javelin Global Commodities Holdings LLP	Ultimate Parent
Javelin Global Commodities Services Ltd.	Parent
Javelin Global Commodities (CH) GmbH	Subsidiary
Javelin Global Commodities (IL) Ltd.	Subsidiary
Javelin Global Commodities (SG) Pte. Ltd.	Subsidiary
Blackjewel Marketing and Sales (UK) Ltd.	Subsidiary
Bluegrass Commodities Holdings LP	Affiliate – Subsidiary of Ultimate Parent
Bluegrass Commodities LP	Affiliate – Subsidiary of Ultimate Parent
Bluegrass Commodities GP LLC	Affiliate – Subsidiary of Ultimate Parent
Javelin Global Commodities Trading (UK) Ltd.	Affiliate – Subsidiary of Parent
Javelin Global Commodities (US) GP LLC	Affiliate – Subsidiary of Ultimate Parent
Javelin Global Commodities (US) LP	Affiliate – Subsidiary of Ultimate Parent
Javelin Hydrocarbon GP LLC	Affiliate – Subsidiary of Ultimate Parent
Javelin Hydrocarbon LP	Affiliate – Subsidiary of Ultimate Parent
Clintwood Marketing and Sales LP	Affiliate – Subsidiary of Ultimate Parent
Clintwood Marketing and Sales (US) GP LLC	Affiliate – Subsidiary of Ultimate Parent
Black Mountain Marketing and Sales LP	Affiliate – Subsidiary of Ultimate Parent
Black Mountain Marketing and Sales GP LLC	Affiliate – Subsidiary of Ultimate Parent
Peter Bradley	Director, Management Board of Ultimate Parent
Spencer Sloan	Director, Management Board of Ultimate Parent
Robert Moore	Management Board of Ultimate Parent
Marc Merrill	Management Board of Ultimate Parent

Transactions with key management personnel

No Directors were paid directly by the Company during the year and there were no other transactions with key management personnel.

Other related party transactions

The following table presents income and expenses incurred with related parties during the year ended 31 December 2019 and 2018 included in the Company's statement of comprehensive income.

	2019	2018
	\$'000	\$'000
<i>Sales of goods and services included in revenue to</i>		
Murray Energy Corporation and affiliated entities	12,790	19,713
Uniper Global Commodities SE and affiliated entities	46,765	91,751
Bluegrass Commodities LP	13,326	15,922
<i>Other income</i>		
Bluegrass Commodities LP	102	-
Black Mountain Marketing and Sales LP	165	-
Clintwood Marketing and Sales LP	112	-
<i>Purchases of goods and services included in cost of sales from</i>		
Murray Energy Corporation and affiliated entities	(769,942)	(981,745)
Uniper Global Commodities SE and affiliated entities	(173,136)	(150,770)

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)
For the year ended 31 December 2019

30. Related party disclosures (continued)

Bluegrass Commodities LP	(15,996)	(56,294)
Black Mountain Marketing and Sales LP	(8,906)	-
<i>Other expenses</i>		
Javelin Global Commodities Services Ltd.: administrative expense	(15,364)	(19,011)
Javelin Global Commodities Trading (UK) Ltd.: administrative expense	(677)	(1,044)
Javelin Global Commodities (CH) GmbH: administrative expense	(859)	(1,552)
Javelin Global Commodities (IL) Ltd.: administrative expense	(978)	(1,072)
Javelin Global Commodities (SG) Pte. Ltd.: administrative expense	(2,561)	(1,277)
Javelin Global Commodities (US) LP: administrative expense	(1,402)	-
Javelin Global Commodities Services Ltd: interest expense	(895)	(1,015)
Uniper Global Commodities SE and affiliated entities: interest expense	(2,442)	(2,663)
<i>Other income</i>		
Bluegrass Commodities LP: interest income	184	-
Black Mountain Marketing and Sales LP: interest income	354	-
Clintwood Marketing and Sales LP: interest income	91	-

The sales to and purchase from related parties are made on terms equivalent to those that prevail in arm's length transactions.

The following table presents the amounts of trade and other receivables and other assets from and trade and other payables to related parties as at 31 December 2019 and 2018.

	2019	2018
	\$'000	\$'000
<i>Trade and other receivables due from</i>		
Javelin Global Commodities Trading (UK) Ltd.	2,061	1,938
Javelin Global Commodities (US) LP	5,425	5,021
Javelin Hydrocarbon	834	801
Bluegrass Commodities LP	7,725	2,904
Black Mountain Marketing and Sales LP	354	-
Clintwood Marketing and Sales LP	91	-
Murray Energy Corporation and its affiliates	3,491	5,959
Uniper Global Commodities SE and its affiliates	974	4,572
<i>Other assets due from</i>		
Bluegrass Commodities LP	11,337	3,653
Black Mountain Marketing and Sales LP	8,930	-
Clintwood Marketing and Sales LP	5,997	-
Murray Energy Corporation and its affiliates	5,000	-
Uniper Global Commodities SE and its affiliates	192	-
<i>Trade and other payables due to</i>		
Javelin Global Commodities Services Ltd.	-	(17,996)
Javelin Global Commodities (CH) GmbH	(807)	(2,549)
Javelin Global Commodities (IL) Ltd.	(611)	(1,124)
Javelin Global Commodities (SG) Pte. Ltd.	(1,377)	(1,129)
Blackjewel Marketing and Sales (UK) Ltd.	(980)	(984)
Murray Energy Corporation and its affiliates	(24,172)	(17,834)
Uniper Global Commodities SE and its affiliates	(8,483)	(79,998)
Bluegrass Commodities LP	(1,367)	(17,834)

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)**For the year ended 31 December 2019****30. Related party disclosures (continued)**

Outstanding trade and other receivables and trade and other payables balances at the year-end are unsecured and interest free and settlement occurs in cash. There have been no guarantees provided or received for any related party trade and other receivables or trade and other payables. The following table presents the amounts of loan and borrowings to related parties as at 31 December 2019 and 2018.

	2019 \$'000	2018 \$'000
<i>Loan and borrowings due to</i>		
Javelin Global Commodities Services Ltd	(32,048)	(27,467)

31. Standards issued but not yet effective

The standards and interpretations that are issued, but not yet effective, up to the date of issuance of the Company's consolidated financial statements are disclosed below. The Company intends to adopt these standards, if applicable, when they become effective.

Amendments to IFRS 3: Definition of a business

The amendments are a response to feedback received from the post-implementation review of IFRS 3. They clarify the definition of a business, with the aim of helping entities to determine whether a transaction should be accounted for as an asset acquisition or a business combination.

The amendments clarify the minimum attributes that the acquired assets and activities must have to be considered a business, remove the assessment of whether market participants can acquire the business and replace missing inputs or processes to enable them to continue to produce outputs. They narrow the definition of a business and the definition of outputs and add an optional concentration test that allows a simplified assessment of whether an acquired set of activities and assets is not a business. The changes are to be applied prospectively to business combinations and asset acquisitions for which the acquisition date is on or after the beginning of the first annual reporting period beginning on or after 1 January 2020. Companies can apply them earlier if they disclose this fact.

Amendments to IAS 1 and IAS 8: Definition of a material

The amendments are a response to findings that some companies experienced difficulties using the previous definition when judging whether information was material for inclusion in the financial statements. The new definition states that information is material if omitting, misstating or obscuring it could reasonably be expected to influence the decisions that the primary users of general purpose financial statements make on the basis of those financial statements, which provide financial information about a specific reporting entity. The changes are effective from 1 January 2020, but companies can decide to apply them earlier.

Amendments to IFRS 9, IAS 39 and IFRS 7: Interest rate benchmark reform

The amendments aim to provide relief for hedging relationships. Many interbank offered rates (IBORs) are expected to be replaced by new benchmark Risk-Free Rates (RFRs) in the next few years. One of the biggest issues presented by the replacement of IBORs is the potential effect on hedge accounting given the extensive use of interest rate benchmarks in global financial markets, and it's this subject that is addressed by the IASB's amendments. Without these amendments, the uncertainty surrounding the replacement of IBORs and the form this will take, could result in entities having to discontinue hedge accounting solely because of the reform's effect on their ability to make forward-looking assessments. In acknowledgement of the speed with which interest rate benchmark reform is progressing, the amendments are effective for annual periods beginning on or after 1 January 2020, with earlier application permitted. They should be applied retrospectively, with early application permitted.

Amendments to IFRS 10 and IAS 28: Sale or Contribution of Assets between an Investor and its Associate or Joint Venture

The amendments address the conflict between IFRS 10 and IAS 28 in dealing with the loss of control of a subsidiary that is sold or contributed to an associate or joint venture. The amendments clarify that the gain or loss resulting from the sale or contribution of assets that constitute a business, as defined in IFRS 3, between an investor and its associate or joint venture, is recognised in full. Any gain or loss resulting from the sale or contribution of assets that do not constitute a business, however, is recognised only to the extent of unrelated investors' interest in the associate or joint venture. The IASB has deferred the effective date of these amendments indefinitely, but an entity that early adopts the amendments must apply them prospectively.

NOTES TO THE FINANCIAL STATEMENTS (CONTINUED)

For the year ended 31 December 2019

32. Events after the reporting period

On 11th February 2020, Murray Metallurgical Coal Holdings LLC who is a producer for Javelin Global Commodities (UK) Limited sales contracts, filed for Chapter 11 bankruptcy in the United States. Murray Metallurgical has continued to operate throughout the bankruptcy proceedings and the court monitored restructuring and all marketing agreements with the Company have been reaffirmed.

On 11th February 2020, as part of the bankruptcy negotiations, Javelin Global Commodities (UK) Limited mutually agreed to reduce the Murray Metallurgical prepetition obligations by \$6.3 million. The entirety of this balance related to 2019 transactions and hence the relevant accounts have been adjusted in the 2019 financial statements. The Company will continue to evaluate the financial statement impact, if any, throughout Murray Metallurgical's bankruptcy proceedings.

On 10th March 2020, Foresight Energy LP and its general partner Foresight Energy GP LLC, who is a producer for Javelin Global Commodities (UK) Limited sales contracts, filed for Chapter 11 bankruptcy in the United States. Foresight Energy has continued to operate throughout the bankruptcy proceedings and the court monitored restructuring and all marketing agreements with the Company have been reaffirmed. On April 29 2020, as part of the bankruptcy negotiations, Javelin Global Commodities (UK) Limited mutually agreed to reduce the prepetition Foresight Energy obligations by \$3.5 million. \$1.2 million of the agreed reduction related to 2019 balances and hence the relevant accounts have been adjusted in the 2019 financial statements. The Company will continue to evaluate the financial statement impact, if any, throughout Foresight Energy's bankruptcy proceedings.

The Directors have carefully considered the potential impact of COVID-19. The Directors are of the view that there will be no material long term impact on the Company's operations. The Company trades with reputable counterparties and often uses credit support (e.g. letters of credit) or various security arrangements when transacting with lower credit quality counterparties. From an operational perspective, the Company has implemented an effective work from home strategy for all employees and consequently the Group is able to continue trading.

There is significant volatility in the financial markets at present. To date, Javelin has maintained reduced levels of market exposure relative to the limits imposed by the Board of Directors given market uncertainty. As a trading operation, the Company remains opportunistic and can use its access to the financial markets to take advantage of increased volatility. The Directors will be actively monitoring liquidity and counterparty risk given this current volatility.

There have been no other significant events affecting the Company since the financial position date.

The world's first fossil-free steel ready for delivery

SSAB has now produced the world's first fossil-free steel and delivered it to a customer. The trial delivery is an important step on the way to a completely fossil-free value chain for iron- and steelmaking and a milestone in the HYBRIT partnership between SSAB, LKAB and Vattenfall.



In July, SSAB Oxelösund rolled the first steel produced using HYBRIT technology, i.e., reduced by 100% fossil-free hydrogen instead of coal and coke, with good results. The steel is now being delivered to the first customer, the Volvo Group.

“The first fossil-free steel in the world is not only a breakthrough for SSAB, it represents proof that it’s possible to make the transition and significantly reduce the global carbon footprint of the steel industry. We hope that this will inspire others to also want to speed up the green transition,” says Martin Lindqvist, President and CEO of SSAB.

“Industry and especially the steel industry create large emissions but are also an important part of the solution. To drive the transition and become the world's first fossil-free welfare state, collaboration between business, universities and the public sector is crucial. The work done by SSAB, LKAB and Vattenfall within the framework of HYBRIT drives the development of the entire industry and is an international model”, says Minister of Trade and Industry of Sweden Ibrahim Baylan.

“It’s a crucial milestone and an important step towards creating a completely fossil-free value chain from mine to finished steel. We’ve now shown together that it’s possible, and the journey continues. By industrializing this technology in the future and making the transition to the production of sponge iron on an industrial scale, we will enable the steel industry to make the transition. This is the greatest thing we can do together for the climate,” says Jan Moström, President and CEO of LKAB. “It’s very pleasing that the HYBRIT partnership is once more taking an important step forward and that SSAB can now produce the first fossil-free steel and deliver to the customer. This shows how partnerships and collaboration can contribute to reducing emissions and building

competitiveness for industries. Electrification is contributing to making fossil-free living possible within one generation,” says Anna Borg, President and CEO of Vattenfall.



SSAB, LKAB and Vattenfall created HYBRIT, Hydrogen Breakthrough Ironmaking Technology, in 2016, with the aim of developing a technology for fossil-free iron- and steelmaking. In June 2021, the three companies were able to showcase the world's first hydrogen-reduced sponge iron produced at HYBRIT's pilot plant in Luleå. This first sponge iron has since been used to produce the first steel made with this breakthrough technology.

The goal is to deliver fossil-free steel to the market and demonstrate the technology on an industrial scale as early as 2026. Using HYBRIT technology, SSAB has the potential to reduce Sweden's total carbon dioxide emissions by approximately ten per cent and Finland's by approximately seven per cent.

“We'll be converting to electric arc furnace in Oxelösund as early as 2025. This is the first production site within SSAB to make the transition, and it means that we'll already be cutting large amounts of carbon dioxide emissions then. This is a major responsibility, one that we're proud to shoulder, and it brings great opportunities to the region,” says Johnny Sjöström, Head of SSAB Special Steels Division.

Press Contacts:

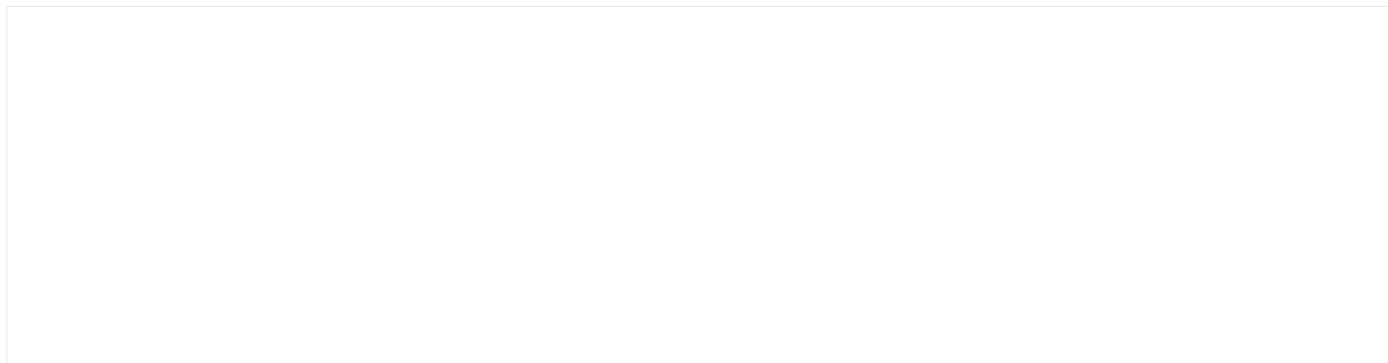
Mia Widell, Public Relations Officer, SSAB, +46 76-527 25 01
 Anders Lindberg, Group Media Relations Manager, LKAB, +46 (0)72-717 83 55
 Magnus Kryssare, Press Officer, Vattenfall, +46 76 769 56 07



A piece of the future - The first object from a piece of the world's first fossil-free steel.

"The candle holder, with its softly pleated rays beaming out from the candle, symbolizes the light at the end of the tunnel. It is a symbol of hope. It truly is... a piece of the future."

Lena Bergström, Designer



ENERGY

Behold, Carbon-Free Steel Now Exists

HYBRIT, a partnership between a mining firm, an electric utility, and a steel company, made the world's first delivery of clean steel to Volvo.

By Dharna Noor8/20/21 1:05PM | Comments (52) | Alerts



Photo: Sean Gallup (Getty Images)



This week, a Swedish firm announced it had delivered carbon-free steel to a customer—a world-first. It's a huge step in the race to clean up one of the most carbon-intensive activities on Earth.

ADVERTISEMENT

On Wednesday, HYBRIT, a partnership between steel company SSAB, state-owned mining firm LKAB, and state-owned utility Vattenfall, said it delivered the clean steel to Swedish automaker Volvo. This was just a test run, but the firm plans to ramp up production to commercial scale by 2026.

“The first fossil-free steel in the world is not only a breakthrough for SSAB, it represents proof that it’s possible to make the transition and significantly reduce the global carbon footprint of the steel industry,” Martin Lindqvist, president and CEO of SSAB, said in a [statement](#).

Making steel is [notoriously difficult](#) to decarbonize. The majority of production relies on coal as a raw material feedstock and also as a fuel. HYBRIT has been working to build out clean steel production since it was formed five years ago using renewable power to produce hydrogen and then combining it with iron ore to create a porous material called sponge iron. It began testing the process, which had only been proven at a laboratory scale, last year. This past June, the venture announced it had successfully used this process on a [pilot scale](#). Volvo plans to experiment with the initial batch of green steel by making prototype vehicles and parts, according to the [Guardian](#).

Related Stories

- The World Is Officially Free of Leaded Gasoline
- The Patriots Aren't Even Robert Kraft's Grossest Investment
- RIP LinkedIn Stories, 2020-2021

In a sea of new technologies created to take on the climate crisis, this breakthrough is actually big news. The world relies on steel to manufacture countless goods—cars, buildings ships, surgical materials, kitchen cutlery, you name it. According to the [International Energy Agency](#), the iron and steel sector is responsible for 2.8 gigatons of carbon dioxide emissions annually, [accounting](#) for 8% of all global energy demand and 7% of energy-related carbon emissions. If production were a country, it would slot in as the fourth-biggest carbon polluter on Earth, sandwiched between the European Union and India. If HYBRIT can create steel without all that pollution, that means other entities can, too. And that needs to happen, fast.



G/O Media may get a commission

SAVE \$50

HP Chromebase 21.5 inch All-in-One Desktop

Great for students and gamers!

The 90-degree rotating screen makes transitions simple.

Buy for **\$500** at HP

To meet the Paris Agreement target of 1.5 degrees Celsius (2.7 degrees Fahrenheit) will require drawing down emissions more than 7% each year this decade. The world is already falling behind that pace. While it still needs to do things like ending fossil fuel exploration and use, speeding up the production of green steel beyond one company could also help get things back on track. Seeing so many state-owned ventures involved is also a reminder that strong policy and government support is vital to speed up the transition.

Subscribe to our newsletter!

From life on Earth to everything beyond, we've got it covered. Subscribe to our newsletter.

Type your email

Sign Me Up

By subscribing you agree to our [Terms of Use](#) and [Privacy Policy](#).

MORE FROM GIZMODO

- The Final *No Time To Die* Trailer Suggests It's Actually Time to Die, Mr. Bond [Update: It Is Once Again Time To Die]
- AT&T Leaves New Orleans Unable to Contact 911 During Hurricane Ida
- Inspiring: Tucker Carlson Offered Money to Help a Banned Anti-Vaxx Conspiracy Theorist Sue Twitter

Review

Review on the Use of Alternative Carbon Sources in EAF Steelmaking

Thomas Echterhof 

Department for Industrial Furnaces and Heat Engineering, RWTH Aachen University, 52074 Aachen, Germany; echterhof@iob.rwth-aachen.de; Tel.: +49-241-802-5958

Abstract: Steelmaking in the electric arc furnace (EAF), either scrap-based or based on hydrogen direct reduced iron, will in future contribute substantially to the reduction of CO₂ emissions in the iron and steel industry. However, there still will be the need to introduce carbon into the EAF process either to carburize the steel or to create foaming slag to improve the energy efficiency of the melting process. So, to reach the emission reduction goals set around the world, it will be necessary to substitute fossil charge and injection carbon used in EAF steelmaking with alternative carbon sources. This review presents the recent research on carbon-neutral biomass-based and circular rubber or plastics-based carbon sources and their potential to substitute fossil charge or injection carbon in the EAF process. It also discusses the current state-of-the art and suggests further opportunities and needs for research and development to use alternative carbon sources to produce a really green and carbon neutral and/or fully circular steel.

Keywords: electric arc furnace (EAF); steelmaking; carbon sources; biomass; plastics



Citation: Echterhof, T. Review on the Use of Alternative Carbon Sources in EAF Steelmaking. *Metals* **2021**, *11*, 222. <https://doi.org/10.3390/met11020222>

Academic Editor: Valentina Colla

Received: 30 December 2020

Accepted: 20 January 2021

Published: 27 January 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Apart from the energy production sector, the iron and steel industry is one of the biggest consumers of fossil coal around the world and therefore also one of the biggest industrial emitters of CO₂. In the countries of the European Union (EU-27, as of 2007 to 30 June 2013), between 4% and 7% of anthropogenic CO₂ emissions are estimated to be originating from iron and steel production [1]. According to the International Energy Agency [2], the steel industries coal consumption accounts for 13.7% of the world's total annual production or 1.1 billion t in 2013. About 80% of this coal is coking coal for the use in coke ovens to produce the coke needed especially in blast furnaces for iron production [3]. Up to now, only a very small part of the total energy is supplied by renewables like biomass or waste in the iron and steel industry. In 2015, only 0.1% of the total energy sources of the iron and steel industry in OECD (Organisation for Economic Co-operation and Development) countries were supplied by renewables and waste [4]. For comparison, in the non-ferrous metals industry, the share was equally low whereas in the non-metallic minerals industry the share was as high as 7.2% which certainly can be mainly attributed to cement kilns using all kinds of alternative fuels.

Greenhouse gas (GHG) emissions, especially CO₂ emissions, are an important issue for the steel producers because of national and international GHG emissions reduction plans and/or emissions trading systems. The UN's 2030 Sustainable Development Goals, the Paris Agreement, as well as the European Green Deal all aim to improve the sustainability of industrial production and to reduce CO₂ emissions to combat climate change. Within the EU Emission Trading System (ETS), which the iron and steel industry is subject to, emission targets of 73.2% below 2005 levels have been set [5]. Now, Europe aims to reach a 55% CO₂ emission reduction until 2030 and carbon neutrality and a circular economy by 2050 [6]. This goal cannot be achieved without the iron and steel making industry substituting its fossil carbon consumption by renewable alternatives.

Therefore, the research on the possibilities of a substitution of fossil coals in iron and steelmaking is increasing more and more. The two main routes to produce steel are the integrated blast furnace-basic oxygen furnace (BF-BOF) route and the electric steelmaking route employing the electric arc furnace (EAF). In 2018 the BF-BOF route had a share of the total worldwide crude steel production of 70.7% while EAF steelmaking accounted for 28.9%. However, looking at specific regions the share of EAF steelmaking can be a lot higher. In the EU 41.5% and in North America about 67% of the steel was produced in the EAF route in 2018 [7]. The integrated BF-BOF route is characterized by the two-step process to first produce iron as liquid hot metal in the BF, which is then processed into steel in the BOF. The EAF route, on the other hand, is characterized by the use of mainly solid materials, like scrap, direct reduced iron (DRI), hot briquetted iron (HBI), or pig iron, that are melted in the EAF.

Especially regarding the ironmaking process, which is the main consumer of fossil coals in the iron and steel industry, a number of reviews regarding the use of alternative carbon sources like biomass have already been conducted and published [8–16]. Even so, the amounts are much lower in EAF steelmaking, and fossil carbon sources are used, contributing to the direct GHG emissions of the steelmaking process. However, there are up to now no reviews about the use of alternative carbon sources in EAF steelmaking available. Therefore, in this paper, the use of carbon in EAF steelmaking is first described. Following that, recent research on the use of alternative carbon sources is presented to give an overview on the possibilities to substitute fossil carbon by biomass or waste-based materials.

2. Carbon Use in EAF Steelmaking

In the EAF, iron sources like scrap, DRI/HBI, or pig iron are charged together with materials like alloying elements, slag formers, and carbon sources. The charged material is then melted by a mix of electrical and chemical energy. The electrical energy is introduced into the furnace via electrodes by the electric arcs ignited between electrodes and charged material. The chemical energy is usually introduced by oxyfuel burners but also e.g., by hydrocarbons from scrap contaminants (paint, oil, grease, etc.) and charged carbon. Apart from the steel melt, a slag is also produced based on slag formers like lime and dolomite which will incorporate iron oxides and oxidic impurities from scrap or gangue from DRI/HBI.

Carbon sources are of great importance in the electric arc furnace. In modern electric arc furnaces, the share of energy input from fossil fuels like natural gas and coal is over 40% of the total energy input [17]. In addition to their energetic use as a substitute for electrical energy, carbon sources are used in particular as slag foaming agents [18]. Solid carbon sources, like coal, petrol, coke, etc., are used in the EAF in two ways. The charge carbon is charged together with the scrap or other iron sources and additives at the beginning of the heat. This carbon serves to carburize the melt, contributes thereby to the slag foaming and by direct oxidation during meltdown realizes a chemical energy input. The injection carbon on the other is injected into the EAF via lances or injectors together with oxygen to generate CO bubbles within the slag and thereby to foam the slag.

According to a study by the International Iron and Steel Institute (IISI), on average, about 12 kg of coal are used per ton of steel produced in the EAF [19]. With a global steel production in 2018 of around 520 million t via the EAF route, this corresponds to a fossil coal consumption of over 6 million tons. This coal use causes specific CO₂ emissions of about 43 kg/t steel and related to the total EAF steel production in 2018 CO₂ emissions of about 22 million tons.

Looking at values of direct CO₂ emissions of EAF steelmaking compiled in studies for the European Commission the benchmark is given with 59 kg CO₂/t steel [20] while the average is given with 102 kg CO₂/t steel [21]. Based on these values, the use of fossil coal in the EAF, besides the use of natural gas and the graphite electrode consumption, is causing

about 40–70% of the direct CO₂ emissions of the EAF steelmaking process. Figure 1 shows a schematic of carbon input and direct emissions of the EAF.

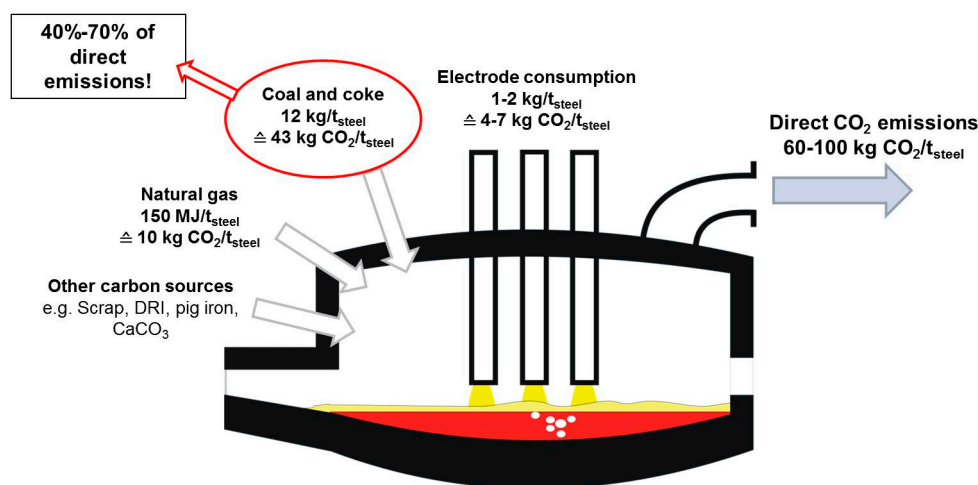


Figure 1. Direct CO₂ emissions of a typical EAF [22].

2.1. Charge Carbon

In comparison to injection carbon, the demands placed on charge carbon are lower. Of particular interest are the calorific value, the reaction behavior as well, as the carburization capacity. If the primary aim of using charge carbon is to carburize the melt, the reactivity must be low enough that the carbon does not burn prematurely but can dissolve in the melt. If the chemical energy input in the melting phase is of primary interest, a high reactivity and therefore a quick energy release may be more important.

Consequently, for charge carbon, the calorific value is of primary importance. With a corresponding cost–benefit ratio, lower carbon contents and higher ash contents are also tolerable as long as no components with the potential to reduce steel quality are introduced into the EAF. Apart from that, the carbon source must have sufficient physical properties to allow for safe handling, storage, and charging into the EAF.

2.2. Injection Carbon

Slag foaming in the EAF is a well-established and widely used method to significantly increase the efficiency of energy transfer in the furnace. The shielding of the electric arcs by the foaming slag reduces the energy losses via the water-cooled furnace walls and roof, thus enabling a significantly improved energy transfer from the arc into the melt. In addition, the slag foaming has a stabilizing effect on the arcs and reduces the noise emissions of the EAF. Approximately 5–10 kg of injection carbon are used in electric arc furnaces [23].

The foaming of the slag by CO/CO₂ gas bubbles occurs in the EAF process via oxidation of carbon dissolved in the molten steel by oxides in the slag (reaction (1)). This foaming process is enhanced and maintained by injecting carbon into the slag. The injected carbon can thereby react directly with the iron oxide according to reaction (2) or reduce the iron oxide indirectly according to reactions (3) and (4) via an intermediate gasification step [24].





Besides carbon, coal usually also contains varying amounts of volatiles, namely hydrogen which is oxidized by FeO to H₂O (reaction (5)). Furthermore, the hydrogen takes part in side reactions (6) (water-gas reaction) and (7) (water-gas shift reaction). Especially the water-gas shift reaction supports the gasification of solid carbon and thereby accelerates the reaction of slag and coal. Hydrogen in the gas phase also increases the carbon gasification rate since H₂ and H₂O react more rapidly with carbon and slag compared to CO and CO₂. Moreover, FeO also reacts faster with hydrogen compared to CO.

Hayes [25] found that the reaction constant of the FeO reduction by H₂ is one order of magnitude greater than that for FeO reduction by CO at 1300 °C and even 5 times greater at 1600 °C. In agreement, Xie and Belton [26] found that reduction rates of ferric iron in slag by H₂/H₂O are a factor of 2–3 times higher than those by CO/CO₂. King [27] demonstrated that the rate of carbon gasification increases linearly with H₂ concentration in carrier gas for hydrogen concentration of up to 4%.

The requirements on the injection carbon for a good foaming effect primarily concern a high reactivity and thus the highest possible carbon content and a low ash content of the coal as well as a defined particle size distribution for pneumatic conveying. With regard to the plant technology used for injection, it should also be noted that no explosion protection is required for the current use of petroleum coke and anthracite coal and is therefore not usually implemented in terms of plant technology. If suitable alternative carbon sources fall into explosion protection classes, substitution may already fail at this point for economic reasons.

3. Alternative Carbon Sources

When using alternative carbon sources, it must generally be considered that the properties of these materials can differ greatly from those of common fossil coals. These differences can have an impact on the steelmaking process in the electric arc furnace. Research has been carried out so far on the use of biomass-based as well as rubber and plastics-based alternatives in EAF steelmaking.

3.1. Biomass Based Alternatives

The research on biomass-based alternative carbon sources includes technical and life cycle assessment studies, fundamental research on slag foaming by biomass and biochars as well as pilot and industrial scale investigations of the use of biomass and charcoal in the EAF.

Mathieson et al. [28] investigated the potential of biomass use in the steel industry of Australia. The focus here was on reducing fossil CO₂ emissions from the metallurgical processes of the blast furnace and electric arc furnace route, with an emphasis on the blast furnace route. In conclusion, the fundamental suitability of biomass carbonisates as a feedstock in iron and steel production is highlighted. They report the CO₂ mitigation potential through biochar utilization for Australian EAF steelmakers with about 6–12%. However, it has to be noted that this is based on the Australian electricity production mix. This results in a high share of 78% of the total emissions of 0.5 t CO₂/t crude steel in EAF steel production, which is caused by electrical energy consumption.

Norgate and Langberg [29] and subsequently Norgate et al. [30] used the life cycle assessment (LCA) methodology to assess the substitution of fossil carbon sources with charcoal as a fuel and reductant in the iron and steelmaking industry of Australia. In addition, they considered economic aspects of the use of carbonisates from biomass and estimated the land requirements for substituting fossil coal with biomass carbonisates. For a complete replacement of fossil carbon sources by biomass carbonisates, they calculate a saving of CO₂ emissions in relation to total (i.e., direct and indirect) emissions of 5.5–11% for the production route in the electric arc furnace. Taking charcoal production by-product

credits into account, they calculated reduction rates of GHG emissions for the EAF route of 7.3–14.7%.

However, these relatively low reduction values for the EAF route stated by Norgate et al. are due to the indirect emissions from electrical energy consumption of the EAF. The calculations are based on the specific emissions of the Australian electricity mix, which are comparatively high at 0.987 kg CO₂/kWh due to a very high proportion of coal-fired power plants. Demus et al. [31] showed that, for the EU-27, with a different electricity mix and specific GHG emissions of 0.43 kg CO₂/kWh, in a very similar scenario, the relative GHG emission reduction potential is almost 29% for the substitution of fossil carbon sources with charcoal in the EAF route.

Sampaio et al. [32] describe an indirect way for the production of green steel in the EAF. They propose the use of cold pig iron (CPI) produced in charcoal operated blast furnaces in combination with scrap. In this scenario the carbon introduced into the EAF by the CPI is considered as carbon-neutral. In [33] Sampaio et al. discuss the use of large amounts of CPI in EAF steelmaking. Based on operational data of a Brazilian steel plant, they compare steel production based on scrap and with an addition of 35% CPI. The use of CPI results in lower residual levels in the produced steel and introduces high amounts of carbon-neutral chemical energy into the system. The high concentrations of carbon (4.3–4.5%), silicon (0.5–1%), and manganese (0.3–0.6%) in the CPI can deliver energy at a rate of about 3.6 kWh/Nm³ oxygen injected into the EAF. The intense CO formation and boiling action during decarburization of the steel melt carburized by the CPI supports the removal of dissolved gases and leads to reduced nitrogen concentrations in the tapped steel of less than 50 ppm compared 90 ppm in scrap-only heats. In [34] Sampaio et al. again discuss the possibility of using in the EAF hot metal from a mini blast furnace utilizing biomass/charcoal as reducing agent. They also present a biomass carbonization process coupled with the mini blast furnace increasing the overall energy efficiency of the coupled processes.

Coming to the more fundamental research on slag foaming by biomass and biochars, Sahajwalla et al. [35] tested differences in wettability of different carbon carriers in contact with EAF slag. The tested carbon carriers were injection coke, petrol coke, natural graphite, synthetic graphite as well as charcoal. The tests included contact angle and volume measurements of a slag sample on a carbon carrier substrate at 1550 °C. Charcoal in comparison exhibited the lowest wettability and therefore minimal foaming of the slag. Natural graphite showed the most favorable behavior with regard to wettability and volume increase of the slag by foaming.

Yunos et al. [36] investigated the combustion behavior of metallurgical coke as well as palm shell/coke and coconut shell/coke blends in thermal gravimetric analysis (TGA) and a drop tube furnace. The combustion efficiency was increased by increasing amounts of palm shells or coconut shells in the blend due to the added volatile matter in the blend. Yunos et al. [37] also conducted a fundamental study on the formation of foamy slag in the EAF with charcoal. For this purpose, they melted down slag samples from the EAF process together with charcoal from palm kernel shells as well as with metallurgical coke as reference material in lab scale and investigated the interaction of the carbon carrier with the slag. They also conducted TGA tests coupled with a mass spectrometer (MS) of both carbon carriers. Differences in reaction behavior were apparent from the gasses formed in the TGA-MS as well as in the melting trials, the different increase in slag volume as well as the number and size of gas bubbles found in the slag. The tests conducted showed that charcoal from palm kernel shells can be an alternative to fossil metallurgical coke for the process of slag foaming.

Fidalgo et al. [38] investigated the thermal behavior of grape seed and pumpkin seed char at high heating rates (1000 K/s) typical for injection into an EAF atmosphere within a wire mesh reactor. As reference materials four different coals used in EAF steel plants were also tested. It was found that the biochars showed different thermal behaviors with the grape seed char exhibiting higher combustion and gasification reactivities. Therefore,

grape seed char was proposed as potential candidate to substitute injection carbon for slag foaming.

Kalde et al. [39,40] tested various biomass-based materials with regard to their reaction behavior at high temperatures within a high-temperature reactor. Based on off-gas analysis data and overall weight loss of the samples they investigated the time dependent gasification in N₂ and combustion behavior in air. They determined specific amounts of produced gas and gas production rates for a number of materials. Considered here were palm kernel shells, wood chip pellets, walnut shells, olive kernels, pyrolyzed wood char, torrefied biomass pellets, as well as pellets made of hydrothermally carbonized green waste and anthracite as a fossil reference coal. Based on the presented investigation technique, it is possible to at least qualitatively compare gasification and combustion behavior of biomasses and biomass carbonisates to choose the best option with regard to gas production rate and the total specific amount of gases produced.

Huang et al. [41] investigated the reaction behavior of different carbon sources with a synthetic EAF slag by sessile drop tests at 1600 °C. The carbon sources investigated included a slow and fast pyrolysis biochar from woody biomass, graphite, metallurgical coke and char from end-of-life tire pyrolysis. Based on observed reaction behavior and measured contact angles between slag and carbon substrate, the authors conclude that the biochars were the least reactive materials in comparison to the other carbon sources. According to their analysis neither ash content nor carbon crystalline structure are significant factors influencing reactivity of the carbon sources with synthetic slag. They conclude that the wettability of the surfaces and therefore the surface roughness of the carbon particles has the biggest influence on the carbon/slag reaction behavior.

Mansuri et al. [42] investigated the high temperature pyrolysis of waste macadamia shells to prepare a carbon source for iron carburization. After pyrolysis the biochar was used to test the carburization of pure electrolytic iron. The biochar created from the macadamia shells via high temperature pyrolysis showed a carbon content of 98 wt.%. In the carburization test, a fast carburization up to 5.2 wt.% of carbon the iron alloy was reached. The carbon dissolution rate was compared with literature data was found to be higher than other carbon sources like metallurgical coke or coal.

Kongkarat [43] tested rubber tree bark in blends with coal and with coal as a reference as a carburizer for liquid steel. In comparison to coal, the carbon content of the steel increased in contact with rubber tree bark and the bark/coal blends. After 30 min of contact, the final carbon content was about 2.8 wt.% for coal and up to 4.9 wt.% for the rubber tree bark.

Bianco et al. [44,45] report about a research project funded by the European Research Fund for Coal & Steel (RFCS). As part of this GreenEAF project the foaming behavior of various biomass carbonisates with EAF slags was analyzed in laboratory scale. For this purpose, mixtures consisting of EAF slag and reference coal or carbonisate samples were placed in a crucible and melted in a furnace. The change in volume of the resulting foaming slag was measured and a qualitatively greater increase in volume of the slags was found when biomass carbonisates were used compared to fossil coal. The fundamental suitability of biomass carbonisates for slag foaming in the EAF could thus be demonstrated.

Tests were also carried out in a pilot-scale EAF, in which fossil charge coal was replaced by biomass carbonisates. Compared to the operation with fossil charge coal, clear differences in the reaction sequences could be determined with the help of gas analysis when biomass carbonisates were used. This was, e.g., reflected in a different timeline of the energy supply in the melting process. The differences were attributed to different reactivities, physical properties, compositions, and carbon contents of the biomass carbonisates in comparison to the fossil charge coal. Notwithstanding this, the general suitability of the biomass carbonisates as batch carbon could be established as no difference in steel quality could be detected [46].

Initial trials on an industrial electric arc furnace with as-is biomass carbonisate from pyrolysis processes were also carried out [45]. The trials showed clear problems in handling

and charging of the fine-grained material into the EAF. However, the industrial trials were able to confirm that no negative influence on product quality is to be expected from the use of biomass carbonisates.

Demus et al. [22,47] subsequently conducted trials on the briquetting of biomass carbonisates and tested the use of the briquettes made from biomass carbonisate in a pilot EAF. The results of the melting tests showed again that the biomass carbonisates have no negative influence on the process. The briquettes made from biomass carbonisate showed similar combustion behavior to conventional charge coal (anthracite coal) and can thus basically be regarded as an alternative feedstock to fossil coal.

Funke et al. [48] investigated the use of a biomass carbonisate from wheat straw fast pyrolysis as charge carbon substitute in the EAF. The carbonisate is a by-product of a biofuel production process and was pretreated by agglomeration prior to the melting trials in a pilot-scale EAF. Molasses in combination with water proved to be a good binder, resulting in sufficiently strong agglomerates. The reaction behavior and release of chemical energy exhibited by the agglomerate was comparable to biochar from slow pyrolysis and also to anthracite coal typically used in EAFs.

Baracchini et al. [49] report on the GreenEAF2 project funded by the RFCS, which is a follow-up to the GreenEAF project. This project was a pilot project to demonstrate the use of biomass and biomass carbonisates in industrial scale. Within the project, various biomass carbonisates but also virgin biomasses available on the market have been sampled and characterized. In subsequent trials the substitution of injection and charge carbon was tested. The industrial injection trials delivered mixed results regarding the achieved slag foaming. Possible reasons identified are the lower biochar density resulting in a reduced penetration of the slag layer by the injected biochar as well as a reduced reactivity of the biochar with iron oxides. The substitution of charge carbon by biochar and biomass, also reported in Cirilli et al. [50] and Echterhof et al. [51], was evaluated positively. The long-term trials of more than 1500 heats resulted in no detrimental effects on steel or slag quality or furnace operation. Moreover, one campaign of about 300 heats using a mix of biomass (palm kernel shells) and fossil coal even resulted in a reduction of the specific energy consumption of the EAF of about 6%.

Meier et al. [52] conducted simulations of the use of biomass in the EAF based on the case of one of the steel plants in the GreenEAF2 project. They used a dynamic EAF process model to simulate complete heats implementing biomass (palm kernel shells) as a charge carbon substitute. The differences between palm kernel shells and anthracite coal like the increased amounts of volatiles have been included in the model. The model was able to deliver results, e.g., regarding the off-gas composition and evolution which were in sufficient agreement with measured off-gas compositions.

Robinson et al. [53] report on lab-scale and industrial carburizing trials with two types of biochar from woody biomass and synthetic graphite and anthracite as reference materials. The woody biomasses tested are commercial wood chips from logging residues and commercial wood pellets from sawdust. All samples were briquetted and added into a molten iron-carbon alloy. The laboratory tests showed that the biochar from sawdust behaved similar to high quality anthracite and showed similar dissolution kinetics. For the industrial trials, a 50 t EAF was used where about 600 kg of carbon sources like anthracite are usually added to the charge material. In trials, one third of the anthracite charge carbon was substituted by the biochar from sawdust. The test heats did not show any deviations from standard operating conditions.

3.2. Rubber and Plastics Based Alternatives

Another possibility for the substitution of coal or anthracite in the EAF is the use of used tires or waste plastics as a carbon source. Used tires contain carbon in the synthetic and/or natural rubber, in textiles and as carbon black. They also contain a significant amount of steel wire, which can be recycled in the EAF. Natural rubber included in the tire can even be considered as carbon-neutral.

The University of New South Wales in cooperation with OneSteel investigated the utilization of waste plastics and rubber and blends of these materials with coke in the EAF. They especially tested the interactions between slag and carbonaceous material with the sessile drop technique. Zaharia et al. [54] investigated metallurgical coke as a reference and two coke/rubber tire blends and their interaction with EAF slag. Based on off-gas data and volume ratios based on visual observations from the sessile drop tests, they concluded that blends of rubber and coke could be used to substitute the coke used in EAF steelmaking. Subsequently, Zaharia et al. [55] again published an investigation of four rubber/coke blends compared to coke with similar results. Zaharia et al. [56] also investigated the combustion behavior of coke, rubber tires and blends of the two in TGA and a drop tube furnace. They found that the combustion performance or burnout increased with increasing rubber content in the blends and therefore correlated directly with the volatile matter content of the blend. In a further publication, Dankwah et al. [57] tested the reduction of FeO-containing slag by blends of end-of-life tires and coke in a horizontal tube furnace in laboratory. They could show that rubber/coke blends exhibited a significantly increased reduction and carburization of the metal than coke alone. It is presumed that the hydrogen introduced by the rubber and the side reactions under participation of this hydrogen led to a faster gasification of the solid carbon and therefore to a faster reduction of the iron oxide in the slag.

Sahajwalla et al. [58] published on the recycling of waste plastics for slag foaming in the EAF. They tested the combustion behavior in a drop tube furnace and subsequently the slag foaming by sessile drop tests. The materials and blends tested were metallurgical coke and a PP (polypropylene)/PE (polyethylene)/coke blend, synthetic graphite and a HDPE (high-density PE)/graphite blend, and petrol coke, HDPE/petrol coke and PP/petrol coke blends. In all cases the volume ratios during slag foaming increased with plastics additions and therefore improved slag foaming. Sahajwalla et al. [59] published a similar investigation on the combustion behavior in a drop tube furnace, this time with HDPE/coke, LLDPE (linear low-density PE)/coke and ABS (acrylonitrile butadiene styrene)/coke blends in comparison to coke. While the combustion efficiency was increased to a similar degree by HDPE and LLDPE, ABS led to an even more significant increase of the combustion efficiency.

Dankwah et al. [60] investigated the kinetics of the reduction of FeO from the EAF slag with HDPE/coke blends in comparison to coke. Due to the high process temperatures in the EAF the polymers decompose into basic hydrocarbons (reaction (8)), especially CH₄ and into carbon and hydrogen respectively (reaction (9)). The hydrogen formed directly reduces iron oxide according to reaction (5) and in the process reacts significantly faster than a reduction with C and CO respectively.



In their investigations, Dankwah et al. could demonstrate that a HDPE/coke blend possesses a significantly increased reaction rate in comparison to pure coke. This is attributed to the hydrogen introduced by the polyethylene and the described reaction mechanisms. Accordingly, it is reasoned that plastics can substitute a part of the coke input into the EAF.

A similar investigation on PP, PET (polyethylene terephthalate), and PU (polyurethane) plastics in a blend with coke was published by Sahajwalla et al. [61]. In all three cases, the blends of polymers with coke exhibited an improved slag foaming behavior compared to pure coke. So, all three blends could be suitable to substitute coke in EAF slag foaming. Sahajwalla et al. [62] again presented results of sessile drop tests with coke, HDPE/coke, rubber/coke, PET/coke and Bakelite/coke blends. While PET/coke and rubber/coke blends showed an increased slag volume, the HDPE/coke blend exhibited a significantly higher slag volume compared to coke. The carbon pickup of the metal was also strongly increased for the HDPE/coke and PET/coke blends in comparison to coke. Sahajwalla

et al. [63] also tested the combustion behavior of HDPE and PP in comparison to metallurgical coke and in blends with coke in a drop tube furnace. Again, they found an increased combustion efficiency with increasing plastics content in the blend. However, the HDPE and PP in the blend was not as effective as rubber investigated previously.

The reduction of FeO-containing EAF slag with PP/coke blends was investigated by Dankwah and Koshy [64]. The extent of reduction was significantly improved by additions of PP to the coke. Also, the carburization of the reduced metal was significantly increased up to 4.95 wt.% in comparison to a reduction by coke alone (0.65 wt.%). Subsequently, Dankwah et al. [65] tested also the reduction of EAF slag by PET/coke blends. Again, they could demonstrate in laboratory that the presence of polymers in the blends increases the extent of reduction and also increases the carburization of the reduced metal up to 5.29 wt.%. Kongkarat et al. [66] investigated the reduction behavior of EAF slag with PET/coke and PU/coke blends. While the PU/coke blends showed a fluctuating slag foaming, the PET/coke blends showed a stable slag foaming. In both cases, the polymer/coke blends showed higher volume ratios than the slag foaming with coke alone. Kongkarat et al. [67] also tested the carburization of pure iron with coke and HDPE/coke blends in a horizontal tube furnace. The addition of HDPE to the coke increased the carbon dissolution into the liquid steel depending on the amount of HDPE in the blend.

Mansuri et al. [68] investigated the high temperature pyrolysis of waste CDs (compact discs), CFRPs (carbon fiber reinforced polymers) and bakelite to prepare a carbon source for iron carburization. After pyrolysis, the three waste polymers show different characteristics with regard to carbon content ranging from 65% to 98%, surface area, and structure.

In addition to laboratory tests, industrial trials were conducted at different EAF steel mills around the world. Gorez et al. [69] described the use of end-of-life tires as a substitute for charge coal or anthracite in two industrial EAF steel works in France. The tires were added as whole tires, shredded tires and even injected as tire powder. The material was added in bulk, in big bags, via injection and via the fifth hole. They could determine a substitution rate of 1.7 kg tire per kg of carbon. They also could determine that the use of up to 8–12 kg/t steel is possible and has no detrimental effect on product quality, emissions or process behavior. However, the addition of tires instead of coal needs more care to ensure that the tires are not only leading to an increase of temperature in the off-gas dedusting system. Ayed et al. [70] subsequently report that the addition of end-of-life tires was also implemented at another French EAF steel works and at a Belgian EAF steel works. They again state that the placement of the tires within the scrap basket is important to optimize the use of the tires. The tires should be put in the middle of the basket to avoid direct contact of the tires with the hot heel on the one hand and to reduce the burn-off through direct contact with the furnace atmosphere on the other hand.

Sahajwalla et al. [71] report on an industrial trial campaign conducted in 2006 at the OneSteel Sydney steel works. In the trials the injection coke for slag foaming was replaced by an HDPE/coke blend. About 22 heats could be evaluated in comparison to standard operation. The use of the HDPE/coke blend led to a better slag foaming according to visual observations, a reduced specific energy consumption (−3%), a reduced power-on time and a similarly reduced tap-to-tap time leading to an increase in productivity. Sahajwalla et al. [72,73] report on trials conducted at OneSteel Sydney and Laverton steel mills. In both EAFs, the injection of a rubber/coke blend is a standard practice. In addition, the injection of an HDPE/coke blend was tested. As a result, the specific energy consumption is in both cases lower than with coke injection, being the lowest with the HDPE/coke blend. Also, the carbon additions could be reduced by about 12% for the rubber/coke blend and by about 15% for the HDPE/coke blend, while FeO content in the slag was reduced slightly.

Joulazadeh [74] reports on similar trials conducted in Iranian EAF steel plants, where coke and coal were replaced by whole end-of-use tires. The trials were conducted in a 6 t foundry EAF as well as in 25 t and 40 t EAF steel plant. Again, there were no negative effects on product quality or pollutant emissions. Based on the trials Joulazadeh reports a decrease

in electrical energy consumption and a decrease in steel production costs, when end-of-use tires are used in the EAF.

Clauzade et al. [75] studied different use cases for end-of-life tires by means of life cycle assessment. They looked at use cases in civil engineering, in energy recovery, e.g., in cement works, as well as material recycling in steel works. Based on tire composition, they also considered the partial biomass origin of the tires. For the use of tires in EAF steelworks the environmental assessment led to intermediate results compared the use of end-of-life tires e.g., in cement works, while there is a significant environmental benefit.

O’Kane et al. [76] describe the polymer injection technology developed and commercialized by OneSteel using a blend of end-of-life rubber tires and coke. The technology is used as standard operating practice in the OneSteel EAF steel works and was also implemented at a number of other EAF steel works around the world. All installations and trials led to a reduction in specific electrical energy consumption as well as a decrease in injected carbon. O’Kane et al. also present a polymer composite briquette consisting of coke fines, waste LDPE flakes and millscale as well as an LDPE-coke briquette. The briquettes have been investigated in laboratory and industrial scale as alternative iron and carbon units to be charged with the basket. While the millscale briquette achieved good reduction in the laboratory tests, the industrial tests of both briquettes showed problems with increased heat generation and overheating of the dedusting system. However, for trials where nutcoke was replaced by LDPE-coke briquettes an overall reduction of electrical energy consumption by 10 kWh/t and a reduction of the power-on time could be observed.

Fontana et al. [77] report on the implementation of OneSteels polymer injection technology at the European EAF steel works of CELSA Group in Cardiff, UK and Mo I Rana, Norway. In both cases, by the injection of a rubber/coke blend instead of coke, the electrical energy consumption could be reduced, the amount of injected carbon could be decreased, the amount of injected oxygen could be decreased, and the productivity could be increased. Emission measurements could prove that there were no increased emissions from the use of rubber/coke blend.

Cirilli et al. [78] studied the utilization of ASR (auto shredder residue) as a carbon substitute in the EAF. The light fraction of ASR, which mainly consists of plastics, rubber, textile and fiber material, was used to produce 150 t of briquettes by pressure extrusion. These briquettes were then used within industrial trials in an EAF to substitute charge coal. To substitute 100 kg coal, 450 kg of ASR briquettes have been charged into the EAF. In a campaign of 29 heats, it was found that the substitution led to a reduction in electrical energy consumption of about 8 kWh/t, while natural gas consumption, oxygen consumption, and tap-to-tap time were not changed. However, it has to be ensured that the ASR briquettes are not charged in the top of the scrap basket, because this leads to an early and rapid combustion of the ASR increasing the temperature in the off-gas duct. An increased substitution of 200 kg of coal with 900 kg of ASR was also tested but led to a temperature overload of the dedusting system, which could not be tolerated. Emission measurements during the trials showed, that there was no negative effect on emission levels including dioxins and furans.

4. Discussion

In view of current developments with regard to GHG-neutral hydrogen-based reduction processes producing H₂-reduced DRI and the subsequent melting in the EAF (e.g., HYBRIT [79], SALCOS [80], H2FUTURE [81]), there will still be the need to introduce carbon into the system either to carburize the steel or to create foaming slag to improve the energy efficiency of the melting process. So, if in the future a substantial part of the steel production shifts to a direct reduction and EAF based route to reach the GHG emission reduction goals set around the world, there will still be a need to use alternative carbon sources to produce a really green and carbon neutral and/or fully circular steel. For the scrap-based EAF route this is true anyway. Here also carbon-neutral slag foaming agents and carburizers will be needed in future.

The literature review could show that there are already solutions available to substitute fossil carbon sources by carbon-neutral biomass-based and circular rubber or plastics-based carbon sources. In some cases, the substitution is already tested in industrial scale or even implemented standard operating practice (SOP) in some EAF steel works. Table 1 summarizes and compares the current state for the different alternative carbon sources discussed. However, there is still room for further research regarding the different use cases of charge and injection carbon, but also regarding the materials used and their treatment or pre-processing.

Table 1. Current state of research and implementation of alternative carbon sources.

Carbon Source	Use	Laboratory	Industrial Tests	SOP ¹	References
<i>Biomass based</i>					
Charcoal from various materials	Injection carbon	3	3	-	[35,37–42,44,45,49]
Virgin biomasses	Injection carbon	3	3	-	[36,39,40,43,49]
Charcoal from various materials	Charge carbon	4	5	-	[44–50,53]
Virgin biomasses	Charge carbon	4	6	-	[49,51,52]
<i>Rubber and plastics based</i>					
Rubber tire/coke blends	Injection carbon	4	9	SOP	[54–57,72,73,76,77]
Polymer/coke blends	Injection carbon	4	7	-	[58–67,71–73]
Pyrolyzed CFRP	Charge carbon	3		-	[68]
Rubber tires	Charge carbon	2	9	SOP	[69,70,74]
Polymer/cokebriquettes	Charge carbon	4	5	-	[76]
ASR briquettes	Charge carbon	2	5	-	[78]

Evaluation of the reported tests and trials according to the technology readiness level [82] by the author; ¹ SOP at least in specific steelworks.

Regarding the use as substitute for injection carbon, currently only blends of polymers and coke have been implemented in industrial scale. While this certainly is a step forward, still a substantial amount of fossil coke is used. Currently, there is no industrially tested solution available for a full substitution of fossil carbon sources for slag foaming. Even so biomass-based materials showed some promising results in laboratory, the industrial tests conducted delivered inconclusive results. Also, there still seems to be further need for research to fully understand all factors influencing the foaming behavior of different alternative carbon sources with EAF slag and the transferability of laboratory results to industrial EAF operation where also aspects like the injection of the material into the slag have to be considered.

Regarding the substitution of charge carbon, the use of biomasses and biomass-based materials seems to be ready for implementation in the EAF. Its implementation mainly seems to be a question of availability and economy at the moment. Also, the use of end-of-use tires has been tested and implemented at industrial EAF steel works for some time now. However, when materials with high volatile matter content like rubber or polymers are used, the charging and also the EAF operation, e.g., post-combustion oxygen use, may need further research and development to ensure, that the energy introduced by the alternative carbon source is used most efficiently within the melting process and does not lead to an overheating and subsequent shutdown of the dedusting system.

Regarding the materials and their treatment or pre-processing, biomasses for example are available from a wide variety of origins and sources all with different compositions and characteristics. Also, there are a number of waste biomasses and wet biomasses, e.g., sewage sludges, that could be made applicable for the EAF by processes like hydrothermal carbonization. In general, the integration of biomass treatment and upgrading processes with the EAF process, e.g., taking advantage of available waste heat potentials, still has further potential for research and development. Moreover, while a lot of waste-plastics, like PP, PET, HDPE, PU, ABS, etc., have already been investigated in the laboratory,

the real material streams, like the ASR mentioned above, can be more complex and thus require additional research regarding possibilities to utilize these circular material streams as an alternative carbon source for EAF steelmaking.

5. Conclusions

This review could show that a lot of research is already available regarding laboratory-scale and also industrial-scale investigation of alternative carbon sources for a substitution of fossil charge and injection carbon in EAF steelmaking. However, it has also been discussed that there is still a lot of potential and need for further research and development in this area.

The EAF steel production route from scrap and/or from hydrogen-reduced DRI will in future play at least an important if not a fundamental role to contribute to the GHG emission reduction in the iron and steel industry. To produce a fully green and carbon-neutral steel, it will be necessary to use alternative carbon sources in the EAF that are either renewable like biomass or at least circular, and maybe in future also produced from renewable sources like plastic or rubber wastes.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable

Informed Consent Statement: Not applicable

Data Availability Statement: Data sharing not applicable.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Pardo, N.; Moya, J.A.; Vatopoulos, K. *Prospective Scenarios on Energy Efficiency and CO₂ Emissions in the EU Iron & Steel Industry*; Publications Office: Luxembourg, 2015; ISBN 978-92-79-54191-9.
2. International Energy Agency. *Coal Information 2015*; IEA Publications: Paris, France, 2015; ISBN 978-92-64-23891-6.
3. International Energy Agency. *Energy Statistics of Non-OECD Countries 2015*; IEA Publications: Paris, France, 2015; ISBN 978-92-64-23897-8.
4. International Energy Agency. *Renewables Information 2015*; IEA Publications: Paris, France, 2015; ISBN 978-92-64-23887-9.
5. Wörtler, M.; Schuler, F.; Voigt, N.; Schmidt, T.; Dahlmann, P.; Lungen, H.B.; Genda, J.-T. Steel's Contribution to a Low-Carbon Europe 2050. 2013. Available online: https://www.stahl-online.de/wp-content/uploads/2013/09/Schlussbericht-Studie-Low-carbon-Europe-2050_-Mai-20131.pdf (accessed on 22 December 2020).
6. European Commission. *The European Green Deal COM/2019/640 Final*. 2019. Available online: <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM:2019:640:FIN> (accessed on 22 December 2020).
7. World Steel Association. *Steel Statistical Yearbook 2019; Concise Version*; World Steel Association: Brussels, Belgium, 2019; Available online: <https://www.worldsteel.org/en/dam/jcr:7aa2a95d-448d-4c56-b62b-b2457f067cd9/SSY19%2520concise%2520version.pdf> (accessed on 22 December 2020).
8. Gielen, D.J.; Moriguchi, Y. Technological potentials for CO₂ emission reduction in the global iron and steel industry. *Int. J. Energy. Tech. Pol.* **2003**, *1*, 229–249. [CrossRef]
9. Ariyama, T.; Murai, R.; Ishii, J.; Sato, M. Reduction of CO₂ Emissions from Integrated Steel Works and Its Subjects for a Future Study. *ISIJ Int.* **2005**, *45*, 1371–1378. [CrossRef]
10. Babich, A.; Senk, D. Biomass use in the steel industry: Back to the future? *Stahl und Eisen* **2013**, *133*, 57–67.
11. Jahanshahi, S.; Deev, A.; Haque, N.; Lu, L.; Mathieson, J.; Norgate, T.; Ridgeway, P.; Rogers, H.; Somerville, M.; Zughbi, H.; et al. Recent progress in R&D on assessment of the use of biomass/designer chars for steel production. In Proceedings of the Innovation of Ironmaking Technologies and Future International Collaboration-to Overcome Energy & Resource Restrictions in Accordance with Environments, Tokyo, Japan, 10–11 November 2014; 54th Committee on Ironmaking of Japan Society for Promotion of Science, Ed.; pp. 123–138.
12. Jahanshahi, S.; Mathieson, J.G.; Somerville, M.A.; Haque, N.; Norgate, T.E.; Deev, A.; Pan, Y.; Xie, D.; Ridgeway, P.; Zulli, P. Development of Low-Emission Integrated Steelmaking Process. *J. Sustain. Metall.* **2015**, *1*, 94–114. [CrossRef]
13. Mathieson, J.G.; Somerville, M.A.; Deev, A.; Jahanshahi, S. Utilization of biomass as an alternative fuel in ironmaking. In *Iron Ore*; Lu, L., Ed.; Elsevier: Waltham, MA, USA, 2015; pp. 581–613. [CrossRef]
14. Mousa, E.; Wang, C.; Riesbeck, J.; Larsson, M. Biomass applications in iron and steel industry: An overview of challenges and opportunities. *Renew. Sust. Energy Rev.* **2016**, *65*, 1247–1266. [CrossRef]
15. Suopajarvi, H.; Kempainen, A.; Haapakangas, J.; Fabritius, T. Extensive review of the opportunities to use biomass-based fuels in iron and steelmaking processes. *J. Clean. Prod.* **2017**, *148*, 709–734. [CrossRef]

16. Suopajarvi, H.; Umeki, K.; Mousa, E.; Hedayati, A.; Romar, H.; Kemppainen, A.; Wang, C.; Phounglamcheik, A.; Tuomikoski, S.; Norberg, N.; et al. Use of biomass in integrated steelmaking—Status quo, future needs and comparison to other low-CO₂ steel production technologies. *Appl. Energy* **2018**, *213*, 384–407. [CrossRef]
17. Bianco, L.; Baracchini, G.; Cirilli, F.; Di Sante, L.; Moriconi, A.; Moriconi, E.; Agorio, M.M.; Pfeifer, H.; Echterhof, T.; Demus, T.; et al. Sustainable Electric Arc Furnace Steel Production: GreenEAF. *BHM Berg-und Hüttenmännische Monatshefte* **2013**, *158*, 17–23. [CrossRef]
18. Jellinghaus, M. *Stahlerzeugung im Lichtbogenofen*, 3rd ed.; Verlag Stahleisen GmbH: Düsseldorf, Germany, 1994.
19. International Iron and Steel Institute. *EAF Technology. State of the Art & Future Trends*; IISI: Brussels, Belgium, 2000.
20. Neelis, M.; Worrell, E.; Mueller, N.; Angelini, T.; Cremer, C.; Schleich, J.; Eichhammer, W. Developing Benchmarking Criteria for CO₂ Emissions Ecofys Project Number: PECSGB073248. 2009. Available online: https://ec.europa.eu/clima/sites/clima/files/ets/allowances/docs/benchm_co2emiss_en.pdf (accessed on 22 December 2020).
21. Ecofys and Fraunhofer Institute for Systems and Innovation Research and Öko-Institut. Methodology for the free allocation of emission allowances in the EU ETS post 2012. *Sector Report for the Iron and Steel Industry Ecofys Project Number: PECSNL082164*. 2009. Available online: https://ec.europa.eu/clima/sites/clima/files/ets/allowances/docs/bm_study-iron_and_steel_en.pdf (accessed on 22 December 2020).
22. Demus, T.; Echterhof, T.; Pfeifer, H.; Schulten, M.; Noel, Y.; Quicker, P. Investigations on the use of biogenic residues as a substitute for fossil coal in the EAF steelmaking process. In Proceedings of the 10th European Electric Steelmaking Conference (EEC), Graz, Austria, 25–28 September 2012.
23. Zulhan, Z. *Der Einfluss unterschiedlicher Kohlenstoffträger auf die Schaum Schlackenbildung im Elektrolichtbogenofen*; Shaker Verlag: Aachen, Germany, 2006.
24. Bhoi, B.; Jouhari, A.K.; Ray, H.S.; Misra, V.N. Smelting reduction reactions by solid carbon using induction furnace: Foaming behaviour and kinetics of FeO reduction in CaO-SiO₂-FeO slag. *Ironmak. Steelmak.* **2006**, *33*, 245–252. [CrossRef]
25. Hayes, P.C. The Kinetics of Formation of H₂O and CO₂ During Iron Oxide Reduction. *Metall. Mater. Trans. B* **1979**, *10B*, 211–217. [CrossRef]
26. Xie, D.; Belton, G.R. Kinetics of Reduction of Ferric Iron in Fe₂O₃-CaO-SiO₂-Al₂O₃ Slags under Argon, CO-CO₂, or H₂-H₂O. *Metall. Mater. Trans. B* **2003**, *34B*, 225–234. [CrossRef]
27. King, M.P. The Effect of Hydrogen on Slag Foaming in Electric arc Furnace Slags. Presentation at Graduate Seminar McMaster University, Materials Science and Engineering, Hamilton, ON, Canada, 24 October 2007.
28. Mathieson, J.G.; Rogers, H.; Somerville, M.; Ridgeway, P.; Jahanshahi, S. Use of Biomass in the Iron and Steel Industry—An Australian Perspective. In Proceedings of the EECRsteel 2011, 1st International Conference on Energy Efficiency and CO₂ Reduction in the Steel Industry, Düsseldorf, Germany, 27 June–1 July 2011.
29. Norgate, T.; Langberg, D. Environmental and Economic Aspects of Charcoal Use in Steelmaking. *ISIJ Int.* **2009**, *49*, 587–595. [CrossRef]
30. Norgate, T.; Haque, N.; Somerville, M.; Jahanshahi, S. Biomass as a Source of Renewable Carbon for Iron and Steelmaking. *ISIJ Int.* **2012**, *52*, 1472–1481. [CrossRef]
31. Demus, T.; Reichel, T.; Echterhof, T.; Pfeifer, H. Biochar Usage in EAF-Steelmaking Potential and Feasibility. In Proceedings of the 1st European Steel Technology & Application Days (ESTAD) & 31st Journées Sidérurgiques Internationales (JSI), Paris, France, 7–8 April 2014.
32. Sampaio, R.S.; Chevrant, L.J.d.S.; Filho, F.B.; Martins, T.B.; Fonseca, M.A.P.; de Oliveira, S.P. *The Use of Self-Sustainable Pig Iron in EAF, a Clean and Economic Alternative Virgin Iron Source. A Brazilian Experience*; Technical Report; Acesita: Belo Horizonte, Brazil, 1993.
33. Sampaio, R.S.; Martins, T.B.; Nicacio, P.; Quadro, A.L.; Saab, M.W.; de Sales Chevrant, L.J.; Villanova, E.; Rezende, M.E.A. The Brazilian Experience in Utilizing Large Proportions of Cold Pig Iron in Electric Arc Furnace. In Proceedings of the 5th European Electric Steel Congress, European Electric Steel Congress (EEC), Paris, France, 19–23 June 1995; Fédération Française de l’Acier, Ed.; pp. 62–71.
34. Sampaio, R.S.; Jones, J.; Vieira, J.B. Hot Metal Strategies for the EAF Industry. In Proceedings of the AISTech 2008 Proceedings. AISTech 2008, Iron and Steel Technology Conference, Pittsburgh, PA, USA, 5–8 May 2008; Association for Iron and Steel Technology: Warrendale, PA, USA, 2008; pp. 1–9.
35. Sahajwalla, V.; Rahman, M.; Hong, L.; Saha-Chaudhury, N.; Spencer, D. Influence of Carbonaceous Materials on Slag Foaming Behavior during EAF steelmaking. In Proceedings of the AISTech 2005 Proceedings. AISTech 2005, Iron and Steel Technology Conference, Charlotte, NC, USA, 9–12 May 2005; Association for Iron and Steel Technology: Warrendale, PA, USA, 2005; pp. 639–650.
36. Yunos, N.F.M.; Ahmad, K.R.; Zaharia, M.; Sahajwala, V. Combustion of Agricultural Waste and Coke Blends during High Temperature Processes: Effect of Physical, Chemical and Surface Properties. *J. Jpn. Soc. Exp. Mech.* **2011**, *11*, s261–s266. [CrossRef]
37. Yunos, F.N.M.; Zaharia, M.; Idris, M.A.; Nath, D.; Khanna, R.; Sahajwalla, V. Recycling Agricultural Waste from Palm Shells during Electric Arc Furnace Steelmaking. *Energ Fuel* **2012**, *26*, 278–286. [CrossRef]
38. Fidalgo, B.; Berruoco, C.; Millan, M. Chars from agricultural wastes as greener fuels for electric arc furnaces. *J. Anal. Appl. Pyrol.* **2015**, *113*, 274–280. [CrossRef]

39. Kalde, A.; Demus, T.; Echterhof, T.; Pfeifer, H. Determining the Reactivity of Biochar-Agglomerates to Replace Fossil Coal in Electric Arc Furnace Steelmaking. In Proceedings of the EUBCE 2015 Online Conference Proceedings. 23rd European Biomass Conference and Exhibition, Vienna, Austria, 1–4 June 2015; pp. 497–507. [\[CrossRef\]](#)
40. Kalde, A.; Willms, T.; Demus, T.; Echterhof, T.; Pfeifer, H. Determining the Potential of Biogenic Calcium- and Carbon-Rich Residues as Substitutes in the Electric Steelmaking. In Proceedings of the EUBCE 2016 Online Conference Proceedings. 24th European Biomass Conference and Exhibition, Amsterdam, The Netherlands, 6–9 June 2016; pp. 1642–1649. [\[CrossRef\]](#)
41. Huang, X.-A.; Ng, K.W.; Giroux, L.; Duchesne, M. Carbonaceous Material Properties and Their Interactions with Slag During Electric Arc Furnace Steelmaking. *Metall. Mater. Trans. B* **2019**, *50*, 1387–1398. [\[CrossRef\]](#)
42. Mansuri, I.; Farzana, R.; Rajarao, R.; Sahajwalla, V. Carbon Dissolution Using Waste Biomass—A Sustainable Approach for Iron-Carbon Alloy Production. *Metals* **2018**, *8*, 290. [\[CrossRef\]](#)
43. Kongkarat, S. Recarburization of Liquid Steel Using Rubber Tree Bark: Implication for Utilizing Agricultural Waste in EAF Steelmaking. *Iron Steel Technol.* **2019**, *16*, 64–69.
44. Bianco, L.; Baracchini, G.; Cirilli, F.; Di Sante, L.; Moriconi, A.; Moriconi, E.; Agorio, M.M.; Pfeifer, H.; Echterhof, T.; Demus, T.; et al. Sustainable Electric Arc Furnace Steel Production: GreenEAF. In Proceedings of the 10th European Electric Steelmaking Conference (EEC), Graz, Austria, 25–28 September 2012.
45. Bianco, L.; Baracchini, G.; Cirilli, F.; Moriconi, A.; Moriconi, E.; Marcos, M.; Demus, T.; Echterhof, T.; Pfeifer, H.; Beiler, C.; et al. *Sustainable EAF steel production (GREENEAF)*; Publications Office of the European Union: Luxembourg, 2013. [\[CrossRef\]](#)
46. Demus, T.; Echterhof, T.; Pfeifer, H. Replacement of fossil carbon with biogenic residues in the electric steelmaking process. In Proceedings of the International Workshop EAF Perspectives on Automation, Materials, Energy & Environment, Milano, Italy, 29–30 March 2012.
47. Demus, T.; Reichel, T.; Schulten, M.; Echterhof, T.; Pfeifer, H. Increasing the sustainability of steel production in the electric arc furnace by substituting fossil coal with biochar agglomerates. *Ironmak. Steelmak.* **2016**, *43*, 564–570. [\[CrossRef\]](#)
48. Funke, A.; Demus, T.; Willms, T.; Schenke, L.; Echterhof, T.; Niebel, A.; Pfeifer, H.; Dahmen, N. Application of fast pyrolysis char in an electric arc furnace. *Fuel Process Technol.* **2018**, *174*, 61–68. [\[CrossRef\]](#)
49. Baracchini, G.; Bianco, L.; Cirilli, F.; Echterhof, T.; Griessacher, T.; Marcos, M.; Mirabile, D.; Reichel, T.; Rekersdrees, T.; Sommerauer, H. *Biochar for a Sustainable EAF Steel Production (GREENEAF2)*; Publications Office of the European Union: Luxembourg, 2018. [\[CrossRef\]](#)
50. Cirilli, F.; Baracchini, G.; Bianco, L. EAF long term industrial trials of utilization of char from biomass as fossil coal substitute. *La Metallurgia Italiana* **2017**, *109*, 13–17.
51. Echterhof, T.; Demus, T.; Pfeifer, H.; Schlinge, L.; Schliephake, H. Investigation of palm kernel shells as a substitute for fossil carbons in a 140 t DC Electric Arc Furnace. In Proceedings of the 11th European Electric Steelmaking Conference & Expo. 11th European Electric Steelmaking Conference & Expo, Venice, Italy, 25–27 May 2016; pp. 1–10.
52. Meier, T.; Hay, T.; Echterhof, T.; Pfeifer, H.; Rekersdrees, T.; Schlinge, L.; Elsabagh, S.; Schliephake, H. Process Modeling and Simulation of Biochar Usage in an Electric Arc Furnace as a Substitute for Fossil Coal. *Steel Res. Int.* **2017**, *88*, 1600458. [\[CrossRef\]](#)
53. Robinson, R.; Brabie, L.; Pettersson, M.; Amovic, M.; Ljunggren, R. An Empirical Comparative Study of Renewable Biochar and Fossil Carbon as Carburizer in Steelmaking. *ISIJ Int.* **2020**. [\[CrossRef\]](#)
54. Zaharia, M.; Sahajwalla, V.; Khanna, R.; Koshy, P. Carbon/Slag Interactions between Coke/Rubber Blends and EAF Slag at 1550 °C. *ISIJ Int.* **2009**, *49*, 1513–1521. [\[CrossRef\]](#)
55. Zaharia, M.; Sahajwalla, V.; Saha-Chaudhury, N.; O’Kane, P.; Fontana, A.; Skidmore, C.; Knights, D. Recycling of Rubber Tyres in Electric Arc Furnace Steelmaking: Carbon/Slag Reactions of Coke/Rubber Blends. *High Temp. Mater. Proc.* **2012**, *31*, 593–602. [\[CrossRef\]](#)
56. Zaharia, M.; Sahajwalla, V.; Kim, B.-C.; Khanna, R.; Saha-Chaudhury, N.; O’Kane, P.; Dicker, J.; Skidmore, C.; Knights, D. Recycling of Rubber Tires in Electric Arc Furnace Steelmaking: Simultaneous Combustion of Metallurgical Coke and Rubber Tyres Blends. *Energy Fuel* **2009**, *23*, 2467–2474. [\[CrossRef\]](#)
57. Dankwah, J.R.; Koshy, P.; O’Kane, P.; Sahajwalla, V. Reduction of FeO in EAF Steelmaking Slag by Blends of Metallurgical Coke and End-of-Life Tyre. *Steel Res. Int.* **2012**, *83*, 766–774. [\[CrossRef\]](#)
58. Sahajwala, V.; Khanna, R.; Rahman, M.; Huang, Z.; Tanaka, E.; Saha-Chaudhury, N.; Knights, D.; O’Kane, P. Recycling of Waste Plastics for Slag Foaming in EAF Steelmaking. In Proceedings of the AISTech 2006 Proceedings. AISTech 2006, Iron and Steel Technology Conference, Cleveland, OH, USA, 1–4 May 2006; Association for Iron and Steel Technology: Warrendale, PA, USA, 2006; pp. 547–553.
59. Sahajwala, V.; Lee, J.; Rahman, M.; Zaharia, M.; Koshy, P.; Khanna, R.; Saha-Chaudhury, N.; O’Kane, P.; Dicker, J.; Skidmore, C.; et al. Gas Phase Reactions of Coke Blends with Plastics for Chemical Energy Input into EAF Steelmaking. In Proceedings of the AISTech 2009 Proceedings. AISTech 2009, Iron and Steel Technology Conference, St. Louis, MO, USA, 4–7 May 2009; Association for Iron and Steel Technology: Warrendale, PA, USA, 2009; pp. 627–636.
60. Dankwah, J.R.; Sahajwala, V.; Koshy, P.; Saha-Chaudhury, N.M.; O’Kane, P.; Skidmore, C.; Knights, D. Kinetics of Reduction of FeO in EAF Steelmaking Slag by Metallurgical Coke and Waste Plastics Blends. In Proceedings of the AISTech 2010 Proceedings. AISTech 2010, Iron and Steel Technology Conference, Pittsburgh, PA, USA, 3–6 May 2010; Association for Iron and Steel Technology: Warrendale, PA, USA, 2010; pp. 895–903.
61. Sahajwalla, V.; Kongkarat, S.; Koshy, P.; Khanna, R.; Zaharia, M.; Saha-Chaudhury, N.; O’Kane, P.; Skidmore, C.; Knights, D. Utilization of Waste Plastics in EAF Steelmaking: High-temperature Interactions between Slag and Carbonaceous Materials. In

- Proceedings of the AISTech 2010 Proceedings. AISTech 2010, Iron and Steel Technology Conference, Pittsburgh, PA, USA, 3–6 May 2010; Association for Iron and Steel Technology: Warrendale, PA, USA, 2010; pp. 127–136.
62. Sahajwalla, V.; Zaharia, M.; Kongkarat, S.; Khanna, R.; Rahman, M.; Saha-Chaudhury, N.; O’Kane, P.; Dicker, J.; Skidmore, C.; Knights, D. Recycling End-of-Life Polymers in an Electric Arc Furnace Steelmaking Process: Fundamentals of Polymer Reactions with Slag and Metal. *Energy Fuel* **2012**, *26*, 58–66. [\[CrossRef\]](#)
 63. Sahajwalla, V.; Zaharia, M.; Kongkarat, S.; Khanna, R.; Saha-Chaudhury, N.; O’Kane, P. Recycling Plastics as a Resource for Electric Arc Furnace (EAF) Steelmaking: Combustion and Structural Transformations of Metallurgical Coke and Plastic Blends. *Energy Fuel* **2010**, *24*, 379–391. [\[CrossRef\]](#)
 64. Dankwah, J.R.; Koshy, P. Reduction of FeO in EAF Steelmaking Slag by Blends of Metallurgical Coke and Waste Polypropylene. *High Temp. Mater. Proc.* **2014**, *33*, 107–114. [\[CrossRef\]](#)
 65. Dankwah, J.R.; Koshy, P.; Sahajwalla, V. Reduction of FeO in EAF steelmaking slag by blends of metallurgical coke and end-of-life polyethylene terephthalate. *Ironmak. Steelmak.* **2014**, *41*, 401–409. [\[CrossRef\]](#)
 66. Kongkarat, S.; Khanna, R.; Koshy, P.; O’kane, P.; Sahajwalla, V. Recycling Waste Polymers in EAF Steelmaking: Influence of Polymer Composition on Carbon/Slag Interactions. *ISIJ Int.* **2012**, *52*, 385–393. [\[CrossRef\]](#)
 67. Kongkarat, S.; Cherdhirunkorn, B.; Thongreang, R. Utilization of Waste HDPE for Sustainable EAF Steelmaking: Carbon Dissolution into Liquid Steel. *Steel Res. Int.* **2017**, *88*, 1600168. [\[CrossRef\]](#)
 68. Mansuri, I.; Khanna, R.; Sahajwalla, V. Recycling Carbonaceous Industrial/Commercial Waste as a Carbon Resource in Iron and Steelmaking. *Steel Res. Int.* **2017**, *88*, 1600333. [\[CrossRef\]](#)
 69. Gorez, J.-P.; Gros, B.; Birat, J.-P.; Grisvard, C.; Huber, J.-C.; Le Coq, X. Charging tires in the EAF as a substitute to carbon. *Rev. Metall.* **2003**, *100*, 17–23. [\[CrossRef\]](#)
 70. Ayed, P.; Clauzade, C.; Gros, B.; Huber, J.-C.; Lebrun, C.; Vassart, N. Charging used tyres in the EAF as a substitute for carbon: A success story for LME and Industeel Belgium. *Rev. Metall.* **2007**, *104*, 128–135. [\[CrossRef\]](#)
 71. Sahajwala, V.; Rahman, M.; Khanna, R.; Dicker, J.; Knights, D.; O’Kane, P.; Skidmore, C. Novel Industrial Trials Demonstrating The Use Of Plastics For EAF Slag Foaming. In Proceedings of the AISTech 2007 Proceedings. AISTech 2007, Iron and Steel Technology Conference, Indianapolis, IN, USA, 7–10 May 2007; Association for Iron and Steel Technology: Warrendale, PA, USA, 2007; pp. 1–12.
 72. Sahajwala, V.; Khanna, R.; Zaharia, M.; Kongkarat, S.; Rahman, M.; Kim, B.C.; Saha-Chaudhury, N.; O’Kane, P.; Dicker, J.; Skidmore, C.; et al. Environmentally Sustainable EAF Steelmaking Through Introduction of Recycled Plastics and Tires: Laboratory and Plant Studies. *Iron Steel Technol.* **2009**, *6*, 43–50.
 73. Sahajwalla, V.; Zaharia, M.; Rahman, M.; Khanna, R.; Saha-Chaudhury, N.; O’Kane, P.; Dicker, J.; Skidmore, C.; Knights, D. Recycling Rubber Tyres and Waste Plastics in EAF Steelmaking. *Steel Res. Int.* **2011**, *82*, 566–572. [\[CrossRef\]](#)
 74. Joulazadeh, M.H. Using Scrap Tires in EAFs as a Substitute for Carbon. *Int. J. Iron Steel Soc. Iran* **2008**, *5*, 36–40.
 75. Clauzade, C.; Osset, P.; Hugrel, C.; Chappert, A.; Durande, M.; Palluau, M. Life cycle assessment of nine recovery methods for end-of-life tyres. *Int. J. Life Cycle Ass.* **2010**, *15*, 883–892. [\[CrossRef\]](#)
 76. O’Kane, P.; Fontana, A.; Skidmore, C.; Jin, Z. Sustainable EAF Steelmaking Through The Use of Polymer Technology. In Proceedings of the AISTech 2016 Proceedings. AISTech 2016, Iron and Steel Technology Conference and Exposition, Pittsburgh, PA, USA, 16–19 May 2016; Association for Iron and Steel Technology: Warrendale, PA, USA, 2016; pp. 1–12, ISBN 9781935117551.
 77. Fontana, A.; Alvarez, A.C.A.; Iacuzzi, M.; O’Kane, P.; Jin, Z. Injection of Recycled Rubber Tires in the EAF as Foaming Slag Agent at CELSA Group. In Proceedings of the EEC 2016-11th European Electric Steelmaking Conference & Expo, Venice, Italy, 25–26 May 2016; Associazione Italiana di Metallurgia, Ed.; AIM: Milano, Italy, 2016; pp. 1–10.
 78. Cirilli, F.; Di Sante, L.; Faraci, E.; Fusato, M.; Foglio, G.; Frittella, P.; Filippini, E.; Tolettini, E. ASR utilization as carbon substitute into the EAF. In Proceedings of the Clean Tech 4, The 4th European Conference on Clean Technologies in the Steel Industry, Bergamo, Italy, 28–29 November 2018; Associazione Italiana di Metallurgia: Milano, Italy, 2018; pp. 1–10, ISBN 978-88-98990-18-4.
 79. Pei, M.; Petäjäniemi, M.; Regnell, A.; Wijk, O. Toward a Fossil Free Future with HYBRIT: Development of Iron and Steelmaking Technology in Sweden and Finland. *Metals* **2020**, *10*, 972. [\[CrossRef\]](#)
 80. Salzgitter, A.G. SALCOS-Climate Initiative for Low CO₂ Steel Production. Available online: <https://salcos.salzgitter-ag.com/en/> (accessed on 29 December 2020).
 81. Verbund Solutions GmbH. H2FUTURE Project. Available online: <https://www.h2future-project.eu> (accessed on 29 December 2020).
 82. European Commission. Technology readiness levels (TRL); Extract from Part 19-Commission Decision C(2014)4995. 2014. Available online: https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf (accessed on 29 December 2020).