Implications for the Australian Magnetite Industry of the Introduction of a Price/Tax on Carbon

Independent Report for Policymakers

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EXECUTIVE SUMMARY

Mining and beneficiation of magnetite ore is considerably more energy intensive than conventional direct shipping hematite operations in the Pilbara. As a consequence, magnetite concentrate production is more CO_2 emissions intensive than direct shipping ore (DSO) production, but this can be more than compensated for by emissions savings in overseas ironmaking operations. In the future, when carbon markets operate effectively across international borders, this will be rewarded appropriately. The challenge is the transitional period where carbon is not valued equally across international borders, for example, if Australia introduces a price on carbon before China. It would be dysfunctional if value adding in Australia were penalised or the emerging magnetite industry were disadvantaged in such circumstances. The aim of carbon pricing is to effectively address the global climate change challenge, but avoid perverse outcomes in the transition. A focus on total system emissions will provide better global greenhouse gas emission outcomes and these should not be penalised by how carbon pricing or taxing is implemented in one country. Until a consistent carbon pricing framework exists between Australia and its international trading partners, the inherent value of lower carbon life cycle emissions associated with magnetite concentrate production cannot be realised by its Australian producers

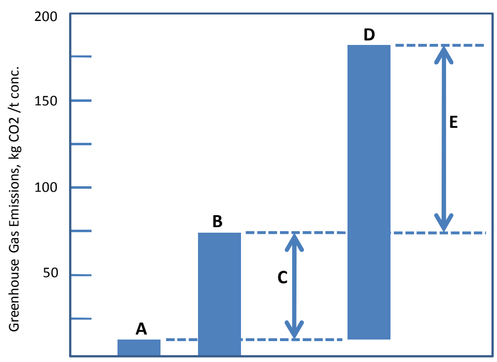
The Crucible Group has been commissioned by the Magnetite Network, to prepare an independent report, drawing on its leading edge modelling capabilities and extensive industry data.

The greenhouse gas benefits of using magnetite concentrates in ironmaking compared to Pilbara hematite fines have been calculated on a Life Cycle basis taken to the blast furnace hot metal stage. Typical reference compositions for magnetite concentrate and hematite fines have been selected for the exercise. For the specific conditions of the reference case, the net Value in Use (VIU) benefits to the ironmaker are 172 kg CO_2e per tonne of magnetite concentrate replacing hematite fines in the blast furnace.

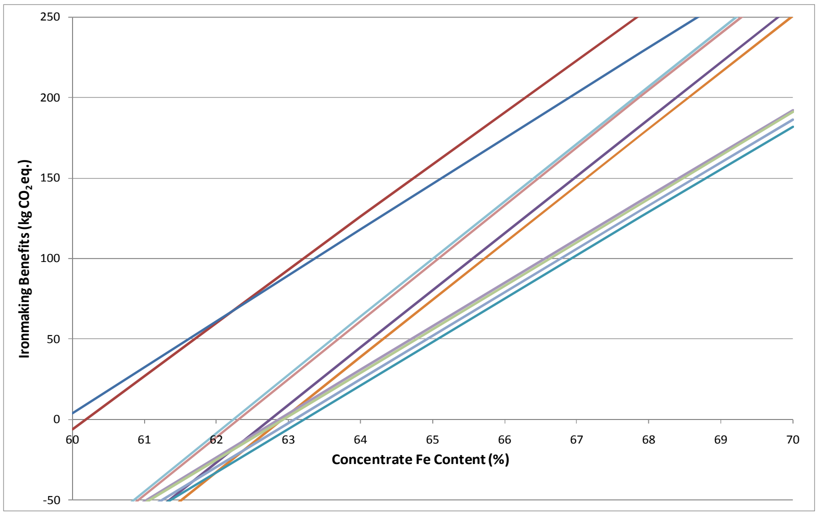
The greenhouse gas emissions associated with production of magnetite concentrate in Australia have also been calculated on a Life Cycle basis taken to the on board ship stage. This is carried out for a particular reference magnetite operation, with a flow sheet typical of the magnetite industry as a whole. For this specific project, the greenhouse gas emissions are 74kg CO_2e per tonne of magnetite concentrate. This is compared to 10 kg CO_2e per tonne attributable to mining operations without beneficiation, based on conventional hematite operations in the Pilbara. This quantifies the ‘beneficiation penalty’ associated with energy intensive upgrading of magnetite ores.

For the reference case conditions, the total system benefits (from ground to steel) of the magnetite proposition are net savings of greenhouse gas emissions of 108 kg CO_2e per tonne of magnetite concentrate, as summarised below.

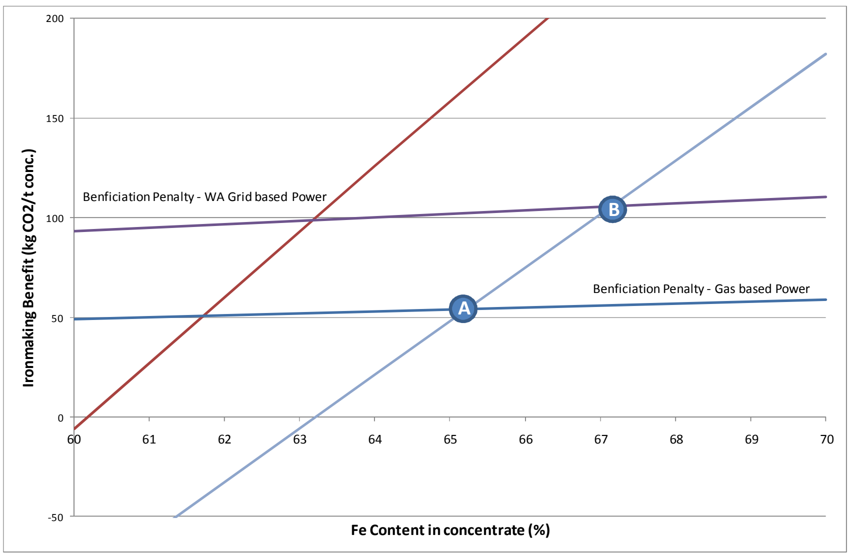
Reference Case Outcomes	CO_2e Emissions
A. Mining operations in the Pilbara without significant beneficiation	10 kg
B. Magnetite concentrate production, with natural gas electricity	74 kg
C. The magnetite “Beneficiation Penalty” (B - A)	64 kg
D. The relative Value in Use benefits of magnetite in ironmaking	172 kg
E. Total system benefits (ground to steel) of the magnetite scenario (D - C)	108 kg



The drivers of the Value in Use benefits of the reference magnetite concentrate compared with the reference hematite (MAC fines) are the thermodynamic advantages of magnetite in reduction to iron, the very low alumina levels (0.1%) and the high Fe content of the magnetite concentrate (67.9%). The beneficiation penalty of concentrate production is driven by the use of electricity in the energy intensive beneficiation steps. In general, the net total system benefits depend on the extent of beneficiation for particular concentrates, the blast furnace operating parameters assumed in the modelling, the hematite fines used in comparisons and how the electricity for magnetite concentrate production is generated. These factors have been modelled in order to make the magnetite proposition more general and more robust. The figure below shows the envelope of outcomes as a function of Fe% in concentrates, with five comparative Pilbara hematite fines and with high and low fluxing regimes assumed for the blast furnace. For this envelope of outcomes, the threshold concentration for which there are net VIU benefits of magnetite extends along a range from around 60% to 63% Fe in concentrate.



The beneficiation penalty for production is significantly increased when electricity is supplied by the grid, as shown below. At the conservative boundary of the envelope of outcomes, the system level threshold concentration, above which the VIU benefits outweigh the beneficiation penalty, increases by some 2% to around 67% Fe when using grid power (marked B), compared to the reference case of natural gas based electricity (marked A).

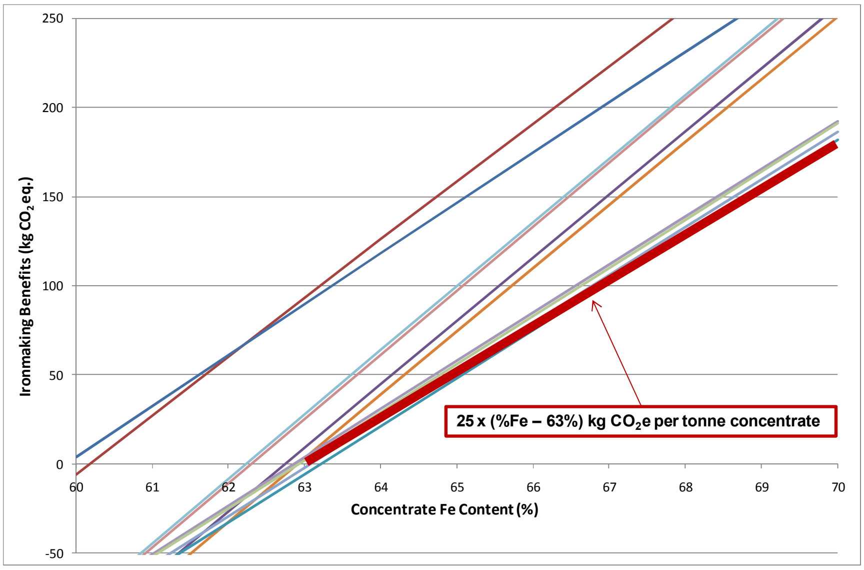


Whilst the magnetite proposition has been developed and quantified in this report using complex modelling, a practical approach for policy making considerations is recommended. This is based on a 'formula' for off shore Value in Use credits, which can be easily applied to different projects across the sector. The simplified formula approach is grounded in the results of the LCA modelling work. It is positioned on the conservative (lower boundary) side of the VIU envelope of outcomes. It should only be applied when, and as long as, the ironmaking customer operates in a jurisdiction without a price on carbon. It should not be applied for magnetite concentrates below the VIU threshold concentration (no offsets generated) and it does not need to be applied for magnetite concentrates above the system level threshold concentration (full offsets achieved).

It is recommended that every tonne of magnetite concentrate production is entitled to a Value in Use offset credit (V_m) equal to 25 kg CO_2e for every 1% Fe above 63%:

$$\mathbf{Vm\ [kg\ CO_2e] = 25 * (Fe\% - 63)}$$

The formula is shown graphically below.



For a given magnetite project, the net "taxable emission" could be calculated as follows:

$$T = E_t - G_e - G_c - V_m$$

where:

- T are the taxable carbon dioxide emissions,
- E_t are total carbon dioxide emissions on a Life Cycle basis,
- G_e are general exemptions from the carbon pricing scheme,
- G_c are government concessions to the magnetite industry and
- V_m are the magnetite concentrate Value in Use offset credits.

For typical magnetite industry conditions, ***T*** will be negative (therefore no net carbon tax liability), because the VIU offset credits will outweigh the beneficiation penalties, ($V_m > E_t$). This study concludes that magnetite producers will generally be able to justify, in a scientifically legitimate and defensible manner, the offsetting of all their greenhouse gas emissions associated with beneficiation and value adding activities in this country, at least until carbon pricing is introduced in steelmaking markets.