Supplementary Information

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Title: Resource intensity trends in the South African ferrochrome industry from 2007 to 2020
Authors: Reuben Dlamini, Harro Von Blottnitz

This supplementary document is in support of the article under review with the details stated above.

Table S1: Summary of similar previous studies reviewed to guide this study.

Study	Scope	Methodology	Conclusions
Mudd, 2007 [7] • Investigated resource intensity trends of gold mining amidst environmental concerns and changing ore grades	**Gold** Africa, Australia, North America & Asia-Pacific	• Investigated ore grade, gold production, waste volumes, greenhouse gas emissions (GGEs), energy use, water use, cyanide use, available economic resources, etc. • Data (assumed high quality) from companies, governments and other mining periodical	• Ore grade was decreasing over time • Cyanide, water, energy use and GGEs increased with decreasing ore grade • A resurgence in production volumes because of advancing technology (modern earth moving equipment, development of carbon-in-pulp (CIP) milling technology) • Results varied with operation conditions
Gediga & Russ, 2007 [15] • Ferrochrome LCA study by ICDA to update previous for benchmarking	**Ferrochrome (FeCr)** 7 ICDA FeCr producers 62.1% FeCr global production Years 2003 to 2005 Finland, Kazakhstan and South Africa	• LCA approach • Data collection from participating companies (material flows and energy consumption) • Horizontal averages were taken for each unit process types • The distinction on was made between with process unit averages • Furnace technology was differentiated	• The industry was more energy efficient in comparison to the 1999 study. • Closed furnaces with preheating were found to be most energy followed by closed furnaces without preheating and open arc furnaces. • The industry was predicted to be more energy efficient with more closed furnaces being used in the industry • The same trend was observed with CO_2 emissions
Glaister & Mudd, 2010 [10] • To evaluate the environmental impacts of Platinum Group Metal (PGM)	**PGMs** 5-10 years prior to the publication of this study South Africa & Zimbabwe	• Mostly used sustainability reports • Investigated sustainability indicators (GGEs, water discharge, energy and water use) • Predicted GGEs based on Processed ore grade and technology used remaining constant	• Ore grade was declining although the reserves were found to be consistent • GGEs increased per unit product over time and predicted to increase due to increasing depth and decreasing ore grades • Water use efficiency was not influenced by scale, ore grade and time. • Energy efficiency was invariable with time whilst ore grade had a subtle correlation.

Study	Scope	Methodology	Conclusions
		• Ore grade and technology were assumed to remain constant with time.	Decreasing production had decreased efficiency. • Underground mines produced more waste rock than open cut mines.
Northey, et al., 2013 [12] • Assessed publicly available data from copper company financial and sustainability reports to determine environmental costs and suitability for use in LCA studies	**Copper** Australia, Argentina, Canada, Chile, Finland, Laos, Papua New Guinea, Peru, Turkey, South Africa & USA Copper companies' reports published from 1996 to 2010	• Investigated the effect of processing routes and declining ore grade on water, energy and GGE intensity • Data was sourced from company sustainability and financial reports • Reports were analysed for consistency and whether they could be used for LCA studies • Data gaps were calculated from other data	• Ore grade was declining causing increase in energy intensity and GGEs but insignificant effect on water • Grind size and smelting technology affected energy intensity. Underground mining required more energy • Water intensity was higher with regions with high water scarcity • Pyrometallurgical routes produced more GGEs than hydrometallurgical routes. • Low quality and scarcity of water led to the increase in energy required to transport and treat the water leading to increased GGEs.
Calvo, et al., 2016 [8] • Investigated energy consumption as a function of ore grade	**Gold, silver, copper, lead, zinc & nickel** Up to 2014 with varying lower limits 16 multinational mining companies	• Focused on energy consumption as function of ore grade over time • Sustainability reports were main data source • Comparison based on metal and production route	• Ore grade was decreasing over time • Resource use and waste generation was noted to increase with decrease in ore grade but there was no clear conclusion regarding specific resource use and ore grade • Energy consumption per unit product metal increased over time due to decreasing ore grade (particularly with underground mining) due to ventilation and depth