Status of specific energy intensity of copper: Insights from the review of sustainability reports

Stephen A. Northey, Nawshad Haque
[1]CSIRO Minerals Down Under Flagship, Bayview Avenue, Clayton, VIC 3168
Corresponding author's email: Stephen.Northey@csiro.au

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There are a range of major industry factors placing upward pressure on the energy intensity of primary copper production. Copper ore grades are declining, mines are becoming deeper and deposits are becoming more complex. However, at the same time the individual processes employed during mining, mineral processing and metal production are becoming more efficient. Given these competing trends, a good question to ask: has the rate of innovation by engineers and the research community been exceeding the upward pressure on energy intensity created by trends at the mine-sites?

A study recently examined the greenhouse gas emissions, water and energy consumption data available in the annual sustainability reports of copper mining operations (Northey et al., 2013). The results of the study (Figure 1) highlighted the variability between operations within the industry and confirm many of the general trends predicted by environmental life-cycle assessment studies (Norgate and Haque, 2010; Norgate and Jahanshahi, 2010). One of these findings is the significant increases in energy intensity with declining ore grades. The database from the previous the study has been re-analysed to determine whether there is any noticeable trend in the energy intensity of copper production over time (Table 1).

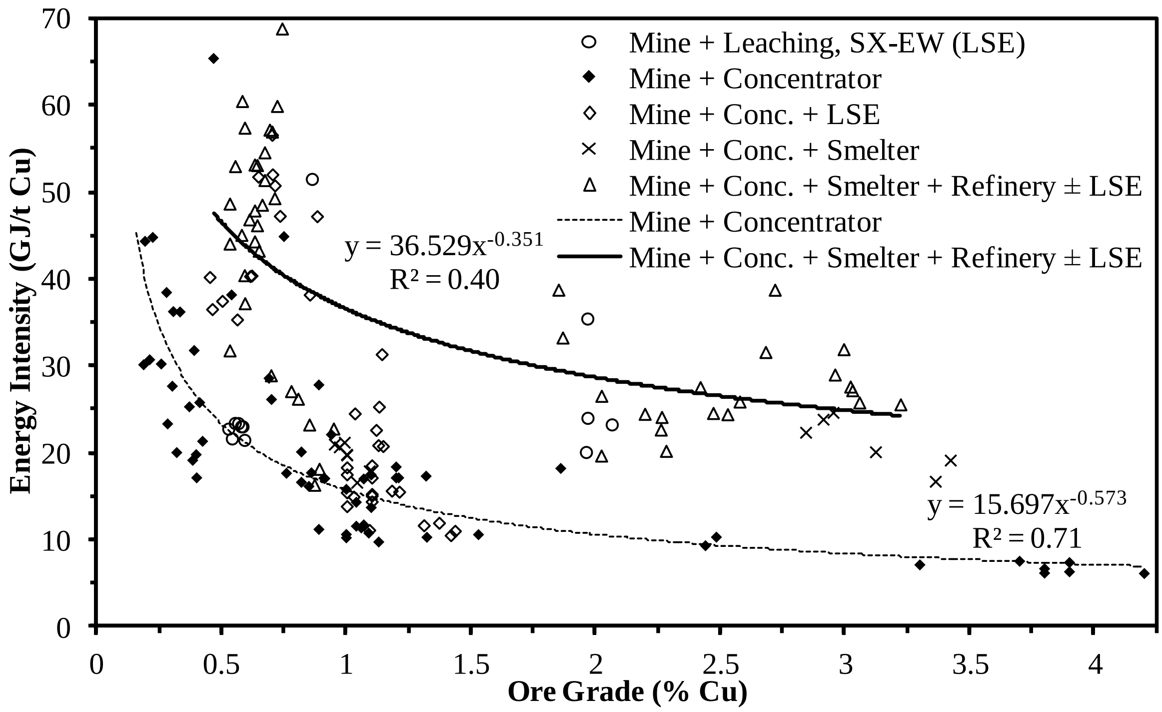

Figure 1: Reported energy intensity of different copper operations (Northey et al., 2013).

Table 1: Reported energy intensity for copper producers. Annual percentage change is relative to the initial year of reporting. Operations that displayed a decrease in energy intensity are shown in red.

	Period	Initial (GJ/t Cu)	Final (GJ/t Cu)	Change (GJ/t Cu)	(%/year)
Smelter 1	2008-2011	9.6	7.7	-1.9	-6.5
Smelter 2	2003-2009	6.9	7.2	0.3	0.7
Smelter 3	2009-2012	13.7	11.5	-2.2	-5.4
Refinery 1	2009-2010	3.3	3.3	-0.1	-1.9
Refinery 2	2005-2010	2.5	2.5	-0.0	-0.2
Company 1	2003-2009	21.7	26.7	5.0	3.8
Company 2	2003-2010	20.6	24.9	4.3	3.0
Mine and Concentrator					
Mine 1	2001-2010	9.9	17.1	7.2	9.1
Mine 2	2003-2010	6.1	7.1	1.0	2.7
Mine 3	2004-2010	21.3	30.2	8.9	7.0
Mine 4	2005-2010	17.1	28.6	11.5	13.4
Mine 5	2008-2010	10.3	10.3	0.0	0.1
Mine 6	2004-2007	19.2	31.8	12.6	22.0
Mine 7	2006-2010	10.6	20.1	9.5	22.5
Mine 8	2005-2009	11.2	17.7	6.5	14.5
Mine 9	2009-2010	18.2	17.3	-0.9	-4.9
Mine 10	2003-2009	17.1	13.7	-3.4	-3.3
Mine 11	2009-2010	17.1	20.0	2.9	16.9
Mine 12	2005-2010	65.4	30.2	-35.3	-10.8
Mine and Leaching, Solvent Extraction-Electrowinning					
Mine 13	2008-2010	27.0	27.6	0.6	1.1
Mine 14	2003-2009	15.3	18.6	3.3	3.6
Mine 15	2003-2009	40.5	52.1	11.6	4.8
Mine 16	2003-2009	21.7	23.1	1.4	1.1
Mine 17	2007-2010	23.3	24.1	0.8	1.1
Mine, Concentrator and Leaching, Solvent Extraction-Electrowinning					
Mine 18	2007-2010	35.4	40.3	4.9	4.6
Mine 19	2006-2009	13.9	15.6	1.7	4.0
Mine 20	2003-2009	20.8	56.7	35.8	28.6
Mine 21	2003-2008	12.0	15.0	3.0	5.0
Mine, Concentrator and Smelter					
Mine 22	2001-2010	20.2	20.8	0.5	0.3
Mine 23	2005-2010	16.8	23.9	7.1	8.5
Mine, Concentrator, Smelter and Refinery					
Mine 24	2003-2010	54.7	48.8	-5.9	-1.5
Mine 25	2009-2010	19.8	16.6	-3.1	-15.8
Mine 26	2001-2010	48.6	53.2	4.6	1.0
Mine, Concentrator, Smelter, Refinery and Leaching, Solvent Extraction-Electrowinning					
Mine 27	2001-2010	19.3	26.3	7.0	4.5
Mine 28	1991-2010	14.1	38.9	24.8	9.8
Mine 29	2001-2010	51.4	47.0	-4.4	-1.1

The limited data for individual smelters and refineries indicate that these operations have been successful in decreasing the energy intensity of copper they produce. The exact reasons for these changes are likely very site specific and could be due to a combination of changes in the composition of feed material and increases in unit process efficiency. Based upon this data, the energy intensity of smelters is approximately 7 to 14 gigajoules per tonne of contained copper (GJ/t Cu) and the energy intensity of refining is approximately 2.5 to 3.3 GJ/t Cu.

The reported increase in energy intensity of mine-site operations significantly exceeds the decreases in energy intensity observed in the smelting and refining stages of production. The weighted average annual increase in energy intensity across all the mine-site operations surveyed was 0.74 GJ/t Cu per year (5.0% per year relative to the first year they reported energy data). A large reason for this increase is due to a decline in ore grades at mine-sites through the periods that they reported. The average rate of ore grade decline at these mines was -0.85% per year (Figure 2). The amount material that has to be moved and processed to produce one tonne of copper contained in product will increase as a result of this.

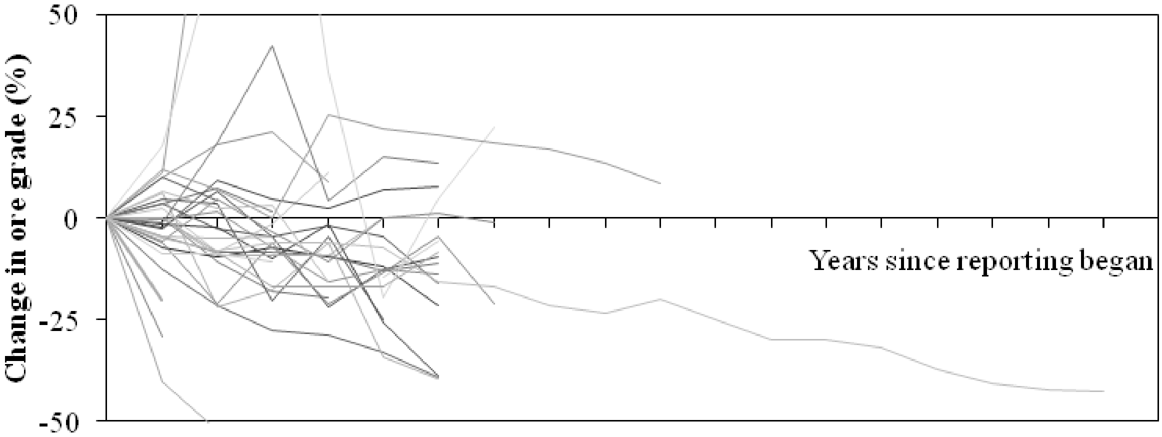

Figure 2: Change in ore grade at individual mines relative to the first year of reported energy data.

This dataset indicates that the energy intensity of copper production is increasing despite the efficiency and optimisation of processes. The trends at the mine site will largely impact upon the energy requirements of mining and concentrating operations. At the same time, further growth in the copper industry will increase the overall energy demands of primary copper smelting and refining. Further innovation is required across all stages of the copper production chain to counteract these trends.

References

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