NOVATEUR PUBLICATIONS
JournalNX- A Multidisciplinary Peer Reviewed Journal
ISSN No: 2581 - 4230
VOLUME 5, ISSUE 5, May -2019

LIFE- CYCLE ASSESSMENT OF THE ENVIRONMENTAL IMPACT ASSESSMENT OF THE MINING INDUSTRY IN MONGOLIA

ENKHBOLD SHINEBAYAR*
BATTULGA SAINJARGAL
Department of Environmental Engineering, Da-yeh University, Taiwan
Email: enhboldshinebayr@gmail.com

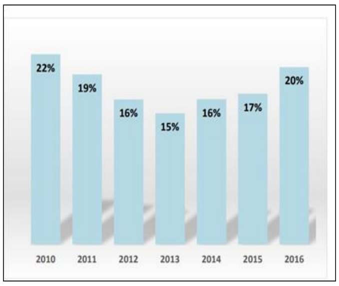
ABSTRACT:

The mining industry is growing rapidly it is important to the national economy of Mongolia.On the other hand, the extraction and processing of mining industries involve particle emission to air or water, toxicity to the environment, contamination of water resources and most importantly decay of human health. The mining industries increase their GDP significantly. However, the most important problem is making the mining Mongolia country sustainable thus reducing the emissions. The main mining industry product includes copper, gold and other minerals. The aim of the study is the application of LCA in the mining industry. To address the environmental impacts caused by the mining sectors in Mongolia, this research is going to analyze the environmental impacts caused by the 3 major minerals extraction processes, which are copper and gold, coal by using the life-cycle impact assessment technologies. This paper presents a review of the current application of LCA in the mining industry. In the results section, SimaPro software version 8.4 using ReCipe and GaBi 4.0™ LCA software was used.

KEYWORD: LCA methodology. Life-cycle assessment. Mining.

I. INTRODUCTION:

Mining is the most dominant industrial sector in our countries with precious metal reserves.This branches one of the core sectors that drive growth in an economy. Not only does it contribute to GDP, but it also acts as a catalyst for the growth of other core industries like power, steel, cement, etc., which, in turn, are critical for the overall development of the economy.Copper, gold, silver and coal mines make up 20-30% GDP and 89% of exports. (Figure.1,2). Mining in Mongolia has not achieved the optimal potential yet and the reserves to production ratios remain low. Illegal mining, unsustainable mining activities, limited explorations, social and political land acquisition issues constrain the supply of the minerals.



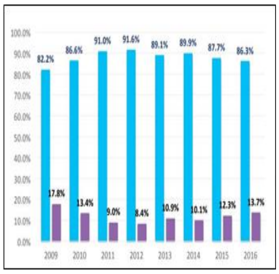


Fig.1 Mining GDP(Mongolia)   Fig.2 Mining export9 (Mongolia)
Source : Ministry of Finance Mongolia

At the same time, it is also valuable in terms of environmental effects,sustainability and global warming as the deeper it goes, the negative impact to environment increases. This issue is more feasible for those countries where mining industry in the leading industrial sector like in South Africa, Russia, Australia, Ukraine and Guinea.[1] On the other hand, mining industries are harmful for air, land, water, human health and biodiversity. The major reasons behind these effects are the harmful emissions from the mining sites and mining methods, mining tailings which get mixed with air/water, extensive mechanism and machinery used in the extraction of deep mining deposits, humans living in the mining area who are exposed to harmful emissions, emitted particles which are non-decayable and works as a restraint for plant and soil growth.During mining time, the soil and plants in the deposit area should be removed which leads to deforestation and soil erosion. Mining metal particles gets mixed with soil which restrains it from plantation thus driving towards destruction to surrounding lands.Water becomes contaminated from acid mine drainage, metal contamination, processing plants, tailing ponds, waste disposal area, active or abandoned surface haulage, etc. At a similar way, biodiversity gets affected by the massive modification of pre-mined landscape and infrastructure.[2] This thesis is going to address the environmental impacts caused by the leading mineral extraction processes in a Mongolia context through life-cycle environmental impact assessment. This section explained how the mineral industry relates to the economies and their use and environmental concerns caused by them. Section 3 explained life-cycle environmental impact assessment core methodologies used in this research. Section 4 defines the impact analysis results in the Section 5 discussed the conclusion and future recommendation.

II. MINERAL SECTOR AND SUSTAINABILITY:

Three of the main mineral industries and their manufacturing technologies are chosen here in this research for sustainability analysis. These are gold, copper, and coal. These minerals and their key properties are briefly explained here.

Gold is easily alloyed with other metals to give it special properties, creating various color changes, making it popular for jewelry.Gold has been used in a wide range of electronic, space aeronautics, and medical applications due to its high conductivity. Complete reflectivity, and absolute resistance to corrosion and oxidation. . In addition, space vehicles integrate gold-coated film to reflect infrared radiation and stabilize the temperature of the spacecraft, and astronauts' face shields are lined with gold to protect their eyes and skin. Gold is also used in the manufacturing of electronic equipment and life-support devices due to its non-reactive and reliable properties. LCA provides Kennecott with a systematic, comprehensive method to evaluate and communicate the environmental impacts of its products and processes. This approach helps the company ensure that a change made in one of its processes will not result in an equal or greater increase elsewhere, including the upstream supply chain. LCA also provides Kennecott with a way to benchmark and improve its operational performance from a sustainable development perspective. Finally, LCA provides Kennecott with a broader view of how its products impact the world, both positively and negatively.[3].

Copper. is ductility led to its use in contemporary plumbing and heating systems.It is corrosion resistance nakes its electrical conductivity remains the key to modern power generation and distribution.The LCA conducted to create the data contained in this Environmental Profile encompasses the copper life cycle from mining the ore to the final production of cathodes at Kennecotts shipping gate.This project included a complete cradle to gate LCA study for copper cathode, molybdenum oxide and sulfuric acid,consistent with ISO 14040 series LCA standards.The functional unit for the study was 1000kg of each product produced.Data gathered for the study represents operations at Kennecotts facilities from July 2002 to June 2003.The study was undertaken for internal use by Kennecott and for communication in a confidential, aggregated maner to select customers and LCA database providers.[4]

Coal. begins as peat, which forms in mires. A mire is a swampy environment that contains the conditions cessary to allow peat to form and collect into more or less thick beds. Peat is converted to coal through a long and complicated process, which will be described in a later section. Coal is composed of complex mixtures of organic and inorganic compounds. The organic compounds, inherited from the plants that live and die in the mires, number in the millions. The more than 100 inorganic compounds in coal either were introduced into the mire from water-borne or windborne sediment or were derived from elements in the original vegetation; for instance, inorganic compounds containing such elements as iron and zinc are needed by plants for healthy growth.[5] At present, assessment of the influence of coal mining focuses on a few of the most important environmental impacts caused by associated processes. Significant negative environmental aspects of hard coal mining include methane emissions into the atmosphere, mining waste and drainage water (Kugiel, 2010).

III. METHODOLOGY:

Since the formalization of environmental life cycle assessment (LCA) by the Society of Environmental Toxicology and Chemistry (SETAC) in the early 1990s, the approach has been widely used in assessing the environmental impacts of various products and systems (Basset-Mens et al. 2007; Battisti and Corrado 2005; Chaya and Gheewala 2007; Socolof et al. 2005). LCA proposes a cradle-to-grave approach to evaluating the environmental impacts of a product or system. This approach provides a comprehensive way to evaluate benefits to society of particular policy choices, product preferences, and system improvements. In this cradle-to-grave approach, every unit process is tracked back to the raw materials and energy inputs and forward to the disposal impacts.

Most industrial processes have mined products as raw materials or coal-generated or nuclear electric power as inputs.[6]

Current LCA applications in mining. The Kennecott LCA project included a complete cradle to gate LCA study for copper cathode, gold, silver, molybdenum oxide and sulfuric acid produced by the mining operation. The methodology used was consistent with ISO 14040 series LCA standards, as shown at a macro level in Figure 3.[7]

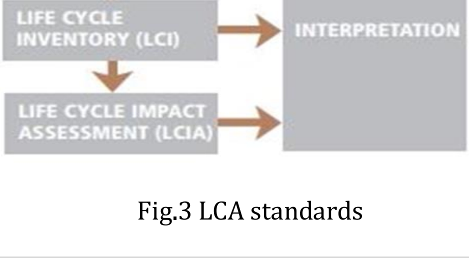


Fig.3 LCA standards

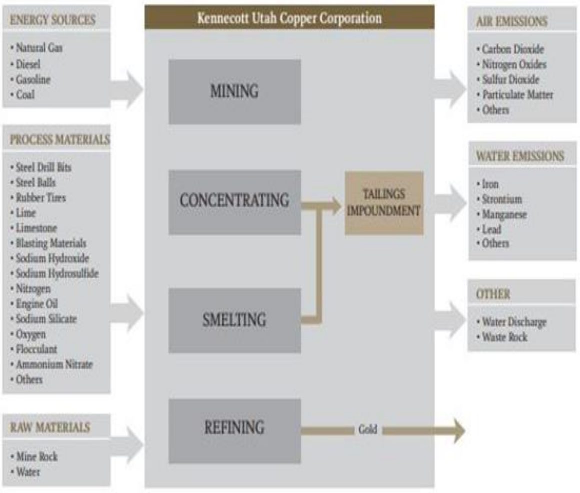


Fig.4 . LCA system boundaries
Source: (Kennecott Utah Copper Gold environmental profile life cycle assessment)

IV. RESULT:

Estimates for potential environmental impacts are organized under two main impact taken chosen categories.These impact categories were selected based on:

A. Primary energy demand (PED)

Exploration of fossil and mineral resources has proceeded rapidly in Mongolia, especially for coal and copper, for which production is now poised to grow four-fold by the end of this decade (IMF 2012). Copper extraction is poised to be a major driver of economic growth in Mongolia, due in large part to the Oyu Tolgoi copper and gold mine, which contains an estimated 25 million tons of copper and 1,100 tons of gold (Temuulen 2010). The mine, situated in the South Gobi region, is also expected to be a large electricity user due to the demands of ore processing equipment such as crushers, grinders, and separators, as it ramps up production in the next few years . Though each demands less overall energy than does mining, together they still comprise a significant fraction of Mongolia's energy demand.

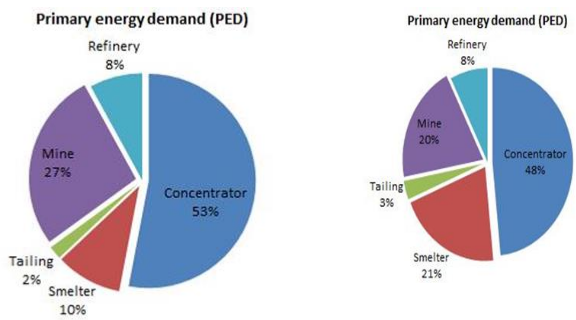
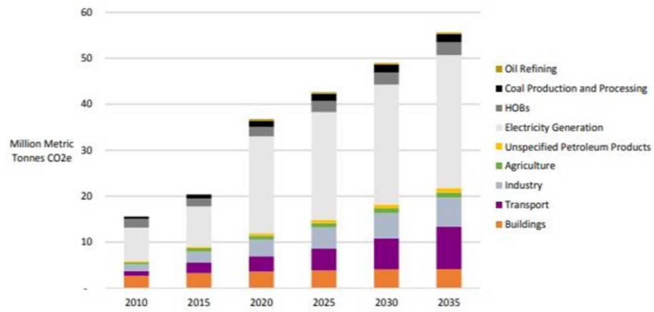


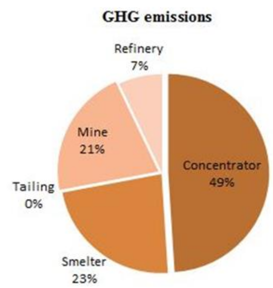
Fig.5 . Breakdown of PED by process group for gold and copper

B. Greenhouse gas emissions(GHG)

Expanded green energy scenario emissions by sector and fuel are half of reference case emissions by 2035, with the most significant reductions being in the electricity generation sector (whether due to energy efficiency or renewable energy), but with reductions throughout the economy. Measures with at least 2 million tons of GHG abatement potential are (from higher to lower potential): energy efficiency improvement in the mining sector, energy efficiency in industrial sectors, wind power, hydropower, appliance efficiency, and transport mode shift to rail. The high potential for these first five measures is not surprising, given the rapid growth in the mining and other industrial sectors, the dominance of GHG emissions from power supply, and the growth in appliance and electronics usage in urban areas (especially UB).[8]



Picture 6. GHG emissions by sector in Mongolia



Picture.7 Breakdown of PED by process group for copper production

V. CONCLUSION AND DISCUSSION:

LCA provides Kennecott with a new, systematic method for evaluating and communicating the environmental aspects it is product and processes.It can help the company ensure that a change made in one of it is processes will not result in an increase elsewhere.It also provides Kennecott with way to benchwark the performance of its products from a sustainable development perspective.Finally,LCA provides Kennecott a broader view of how its product impact the world,bot positively and negatively.[9] This paper examined the environmental impact of the Mongolian mining sector on the LCA method. Two selected components were selected for possible environmental impact assessment. These impact categories were selected based on: primary energy demand,(PED) greenhouse gas emissions(GHG).While this analysis shows what might be possible with assertive efforts by Mongolia's mining industry and other pathways are also possible and may bring similar social, economic, and political benefits. Data availability for energy and environmental analysis in Mongolia is quite bad. However, some areas where the implementation of periodic surveys would benefit future planning efforts, and make the analysis of the energy and environmental policy options more straightforward and accurate.

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