A Framework for Integrating Carbon Emissions into Short-term Planning of Surface Mines

Milad Rahnema and Ali Moradi Afrapoli
IntelMine Lab, Laval University, Quebec, Canada

ABSTRACT

Risks arising from climate change pose financial, environmental, and social threats to the mining industry. The mining industry consumes up to 11% of the global energy, while 70% of the mining projects from the six largest mining companies operate in water-stressed regions (Hund t al., 2020). The mining industry is under pressure from regulators, investors, and society to limit global warming to at or below 1.5 ˚C – 2 ˚C. In response to climate change and sustainability, most mining companies are taking major steps to minimize their greenhouse gas emissions (GHG). According to the Equinix Mining Technology Report (2021-22), 74% of business leaders in the industry cite sustainability as the most critical business issue. Despite its negative impact on the mining industry, the energy transition offers an excellent opportunity for the industry as it pushes the demands for raw materials higher than ever. For example, lithium demand is predicted to rise 965% by 2050 (Sovacool et al.,2020). In this study, we try to explore how the contradicting goals of sustainable mining and the increase in the demand for raw materials will impact the short-term production planning in surface mines. We aim to investigate the possibility of translating the CO2 emissions into a quantifiable factor being imposed to the process of short-term planning in surface mines.

1. Introduction:

Up to 80% of the raw materials are mined using the open pit mining method, a way of extracting near the surface minerals through an open-air pit (Osanloo et al,. 2020). Today, the mining industry is moving toward digitally integrated operations to meet the net-zero emissions targets without compromising productivity. It is necessary to handle the massive quantities of data generated by everyday mining activities to ensure the industry's efficiency. A single large open-pit copper mine can emit up to 200,000 tCO2e, annually. Mitigating carbon emissions in the mining sector requires developing intelligent strategies and planning practices to implement cutting-edge green solutions, methods, and technologies, the mine planning department is not excluded. Our work will focus on finding the best way to incorporate CO2 emission into the process of the short-term planning horizon.

2. Methodology

To consider the effect of carbon emissions in short-term planning, we first establish a life cycle assessment (LCA) framework for the surface mining value chain. LCA enables us to quantify the emission rate depending on production volume (kg CO2e/tonne), which integrates the CO2 emission and financial objectives. The short-term planning model coupled with LCA is an integrated solution to reduce direct and indirect carbon emissions while considering long-term production targets.

ISBN: 978-1-55195-486-8

3. Results and Conclusions

We integrate the LCA techniques with the optimization model in a two-step framework to introduce our integrated short-term production planning algorithm for open-pit mines (Fig. 1). Our framework uses the short-term plan to reduce machine idle times, traffic blockage, unnecessary re-handling, and machine relocation to optimize life-cycle energy use. The framework also considers the block properties and fleet allocation as two main short-term objectives with the highest impact on mining energy consumption. Unprioritized low-grade excavation increases the energy consumption of heavy machines and comminution equipment. Within the framework, the hybrid simulation-optimization algorithm selectively optimizes the short-term production sequence based on two aforementioned factors. It involves real-time optimization of mining blocks and truck-and-shovel allocation to achieve lower carbon emission objectives.

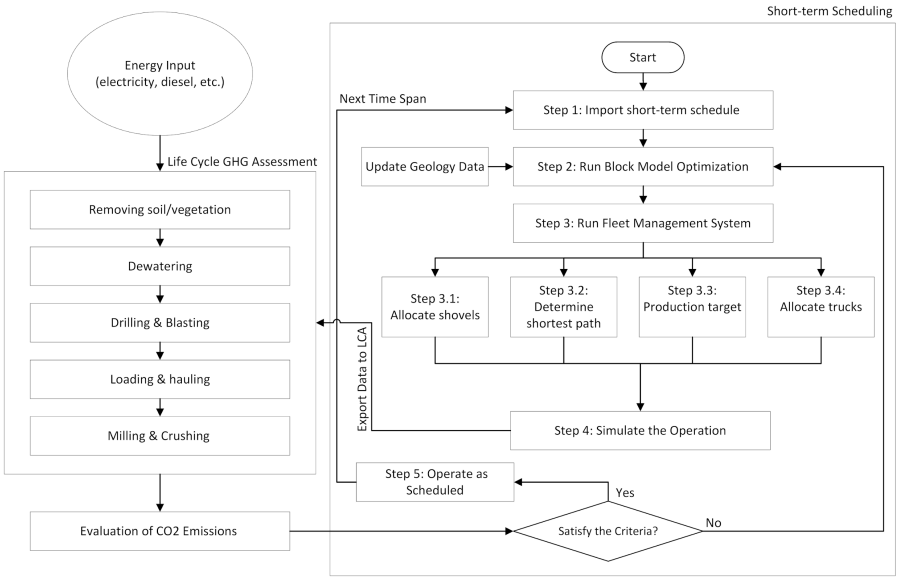

Figure 1. Schematic flow chart of integrated short-term planning with LCA.

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