

Accelerating Fleet Electrification in Mining to Meet ESG Targets: A Simulation and Operational Analysis Approach

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ABSTRACT

As mining companies strive to achieve significant carbon reductions in response to Environmental, Social, and Governance (ESG) targets, the electrification of diesel-powered equipment has become a crucial strategy. However, the industry faces several challenges, including supply chain constraints, long lead times, and technical issues that emerge during the trial periods. Traditional asset acquisition methods are proving inadequate for the unique demands of fleet electrification, leading to delays that jeopardize the timely achievement of ESG goals.

This paper presents a comprehensive approach that combines advanced simulation using Dymola with operational analysis to accelerate fleet electrification in the mining sector. Initially, Dymola is employed to develop and contrast various electrification options, including Hybrid Electric Vehicles (HEVs) and Battery Electric Vehicles (BEVs). The simulation outputs include critical data such as range estimations, battery state-of-charge (SOC) across different operational states, optimal charging point locations, and a detailed financial analysis of the total cost of ownership (TCO) and emissions savings.

Following the simulation phase, we transition to the operational layer, where the integration of electric, diesel, and hybrid fleets is analysed in real-world scenarios. This analysis leverages operational data to evaluate the impact of different fleet compositions on key performance metrics, including total tonnage of ore transported, utilization rates, congestion at charging points, and overall productivity. Several scenarios are explored, such as increasing the number of electric trucks or adjusting the charging infrastructure, to assess their effects on operational efficiency and ESG compliance.

The results provide a clear pathway for mining companies to optimize their fleet compositions and infrastructure investments, thereby accelerating the transition to electrified fleets and ensuring the timely achievement of ESG targets. This dual-layer approach not only speeds up the trial and acquisition process but also offers strategic insights into the operational impacts of fleet electrification, enabling more informed decision-making.