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Material Use & Life cycle GHG Emissions of Different Electrification Options for Long-Haul Trucks

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Abstract : Electrification of long-haul trucks has been in discussion as a potential strategy to decarbonization. These trucks will require large batteries because of their weight and long daily driving distances. Around 245 million battery electric vehicles are predicted to be on the road by the year 2035. This huge increase in the number of electric vehicles (EVs) will require intensive mining operations for metals and other materials to manufacture millions of batteries for the EVs. These operations will add significant environmental burdens and there is a significant risk that the mining sector will not be able to meet the demand for battery materials, leading to higher prices. Since the battery is the most expensive component in the EVs, technologies that can enable electrification with smaller batteries sizes have substantial potential to reduce the material usage and associated environmental and cost burdens. One of these technologies is an ‘electrified road’ (eroad), where vehicles receive power while they are driving, for instance through an overhead catenary (OC) wire (like trolleybuses and electric trains), through wireless (inductive) chargers embedded in the road, or by connecting to an electrified rail in or on the road surface. This study assessed the total material use and associated life cycle GHG emissions of two types of eroads (overhead catenary and in-road wireless charging) for long-haul trucks in Canada and compared them to electrification using stationary plug-in fast charging. As different electrification technologies require different amounts of materials for charging infrastructure and for the truck batteries, the study included the contributions of both for the total material use. The study developed a bottom-up approach model comparing the three different charging scenarios – plug in fast chargers, overhead catenary and in-road wireless charging. The investigated materials for charging technology and batteries were copper (Cu), steel (Fe), aluminium (Al), and lithium (Li). For the plug-in fast charging technology, different charging scenarios ranging from overnight charging (350 kW) to megawatt (MW) charging (2 MW) were investigated. A 500 km of highway (1 lane of in-road charging per direction) was considered to estimate the material use for the overhead catenary and inductive charging technologies. The study considered trucks needing an 800 kWh battery under the plug-in charger scenario but only a 200 kWh battery for the OC and inductive charging scenarios. Results showed that overall the inductive charging scenario has the lowest material use followed by OC and plug-in charger scenarios respectively. The materials use for the OC and plug-in charger scenarios were 50-70% higher than for the inductive charging scenarios for the overall system including the charging infrastructure and battery. The life cycle GHG emissions from the construction and installation of the charging technology material were also investigated.

Keywords : charging technology, eroad, GHG emissions, material use, overhead catenary, plug in charger
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