

Electrifying Saudi Logistics: A TCO and Risk Based Roadmap for Battery Electric Truck Fleets under Vision 2030

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Abstract

This paper evaluates when and where battery electric trucks (BEVs) can economically displace diesel in the Kingdom's logistics network. We build a Saudi specific total cost of ownership (TCO) model for two duty cycles, medium duty return to depot and heavy-duty long haul and embed it in a cost minimization that applies an internal carbon price (ICP). A Monte-Carlo simulation varies diesel and electricity prices, tariffs, grid carbon intensity, and policy shocks to quantify uncertainty in costs and emissions. Results show depot based medium duty BEV fleets are already cost competitive under prevailing industrial tariffs; managed, off-peak charging further improves savings and reduces exposure to oil price volatility. Heavy duty long haul remains cost positive at current prices but approaches parity when the diesel electricity price ratio widens, ICP rises, or standardized corridor megawatt charging is available. Grid decarbonization and carbon pricing materially cut emissions in both segments, yet TCO parity depends primarily on relative energy prices and operational constraints. We propose a phased roadmap for Saudi operators: (i) electrify medium duty first through return to depot operations and smart charging; (ii) pilot heavy duty corridors co located with reliable power and on site renewables; (iii) hedge tariff and capex risk via long term contracts, incentives, and public private partnerships; and (iv) coordinate utilities, fleet operators, and regulators to accelerate grid connections and standardize charging. The framework provides decision-ready evidence for logistics managers and policymakers seeking cost effective, resilient decarbonization of road freight.

Keywords

Fleet electrification, Total cost of ownership (TCO), Internal carbon pricing (ICP), Monte Carlo simulation, Diesel–electricity price ratio, Saudi Arabia logistics (Vision 2030).

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