

A simulation-based model for green fleet management in Colombia

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Colombia is committed to reducing greenhouse gas (GHG) emissions through various initiatives and projects aimed at promoting the adoption of green and sustainable practices in various industry sectors. Our research aims to facilitate the transition to a future of low- or zero-carbon emissions in road freight trucking sector by proposing a simulation-based model adapted to the characteristics of companies operating in the country. The proposed model offers alternative solutions based on scenario analysis and allows companies to anticipate and plan for (un-)expected changes, including fleet renewal and the adoption of specific technologies. The developed Simulator tool is a robust optimization model based on mixed-integer programming (MIP) techniques, enabling companies to use reliable decision-making tools for effective fleet management. The model incorporates primary data obtained through survey research and captures key information about the fleet of companies, such as vehicle age, capacity, route characteristics, maintenance efficiency and costs, saving policies, and estimates of the cost of new vehicles on the market. Furthermore, the model addresses various types of vehicles, including traditional fossil fuel vehicles and low- and zero-emission vehicles, such as hydrogen and electric vehicles.

The aim of the research is to determine the best combination of vehicle types that minimize costs, while reducing emissions and taking into account country-specific constraints. To validate the model, historical data on technology availability, vehicle efficiency, and maintenance costs were also utilized in this research. The model proved its ability to provide insights or guidance on fleet costs and performance over a 27-year period until 2050. The results of the model are presented individually to the participating companies and provide invaluable insights into optimal fleet configuration, appropriate vehicle replacement timing, and effective cost-effective and emission-reducing strategies for fleet renewal.

This research establishes a robust framework for companies seeking to optimize their fleets in the long run. The model offers a guiding compass to companies within Colombia's freight transport sector, facilitating informed decision-making and guiding them towards having Net Zero freight transport operations. By presenting feasible alternative scenarios that consider the trade-offs between acquisition and operating costs and GHG emissions, this novel tool also empowers companies to make informed choices aligned with their predefined sustainability goals. Furthermore, the model's impact extends beyond individual companies, as it informs government policies and can play a vital role in shaping the Colombian freight transport sector towards a sustainable future.

Keywords: Road freight transport, decarbonization, net zero, simulation