MODE AND LOAD SHIFTS IN INTERZONAL LONG-HAUL BATTERY-ELECTRIC TRUCKS UNDER SHORT-TERM VOLATILITY OF ELECTRICITY PRICES

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Problem Statement

The two central levers for decarbonizing road freight are the implementation of battery-electric trucks and the shift to rail transport. The electrification of the long-haul trucking fleet is challenged by the lack of sufficient recharging infrastructure capacities, as well as, the weight and size of batteries. The shift to rail is mostly cost-efficient in the application for transportation routes of longer distances (>400km). The EU's policy packages on the Trans-European Transport Networks tackle the support of both levers by emphasizing the build-up of megawatt charging infrastructure and expanding freight transport capacities in rail. While there is an extensive number of studies dedicated to planning the charging infrastructure, this holistic view, encompassing both electrification and the shift to rail, is considered mostly at a low level of detail. The objective of our work is to address this gap by identifying relevant techno-economic parameters that impact the cost-optimal decarbonization pathway of road freight.

The key research question is: *How do the electricity prices and volatilities in the different electricity market zones effect the spatial allocation of cost-optimal charging loads for battery-electric trucks?*

Methodology

For this, we extend an existing linear programming model that optimizes the total costs related to the vehicle stock, charging activities, and infrastructure expansion of rail mode over a time horizon of 10+ years.

The sizing of required charging capacity happens with the consideration of spatial and temporal flexibility of charging processes by the BEV truck fleet, together with location-dependent differences in charging prices. Moreover, the temporal resolution is hourly which allows us to capture usage patterns of both, fueling/charging and mode infrastructure.

We apply this model to a dataset describing routes of long-haul trucks along the Scandinavian-Mediterranean corridor. We create various scenarios for the development of battery performance (weight and range), the build-up of rail mode capacities, and the efficiency of road-to-rail terminals.

Expected Results

Results will present the potential of spatial flexibility and quantify the charging loads shifted in geographic and temporal dimensions through the variation of electricity prices and day-ahead volatility of electricity prices.

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