Decarbonisation of road freight transport

Think European - and act now!

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Freight transport is of crucial importance for the European economic area and Germany as a business location. The rapid decarbonisation of transport reduces the costs of climate change [Kot24] and avoids penalties for EU member states and truck manufacturers [Kur23, Ace23]. Electrified railways are an important building block for this, but even with optimistic expansion scenarios, the continuing growth in transport volumes in Germany [Klu23], Europe [EUR18] and the world [IEA19] will lead to an increase in transport performance by road.

In order to be able to successfully manage the necessary ecological transformation of road freight transport, industry and logistics urgently need planning security and concrete specifications with regard to the transformation goal. Solutions for this must meet central requirements:

- Low-emission and resource-saving
- Powerful and efficient
- Economical and compatible with logistical processes
- Safe, proven and quick to roll out

Renewable energies are needed in all sectors to achieve climate protection targets. The resulting scarcity requires the use of technologies with high energy efficiency.

Drive systems with alternative fuels (such as HVO and eFuels) and fuel cell trucks have only low overall efficiencies [Pfe21]. To be climate-neutral, they need hydrogen from renewable energies. However, this will only be available in limited quantities in the future and will be urgently needed in the chemical and steel industries as well as in shipping and aviation [Ode22, Mat21, Uec23]. As a result, green hydrogen and fuels based on it will not be economically usable in road transport, or at best in niche applications.

Battery electric trucks (BEVs) are expected to play an important role in road freight transport. However, the exclusive **stationary charging** of vehicles would pose significant challenges for both the transport and energy sectors: The range is limited by the traction battery and high charging capacities are regularly required, e.g. required during driving breaks. In addition, binding charging station availability must be ensured in the event of constantly changing traffic conditions (e.g. traffic jams) so that logistical processes are not impaired. High grid connection costs, limited local grid capacities and the additional space required are also obstacles to the expansion of the charging infrastructure at service stations and logistics locations. Furthermore, the necessary large batteries lead to high vehicle costs and lower payloads, are responsible for a worse CO2 balance, exacerbate resource requirements and geopolitical dependencies. Fast charging also causes the batteries to age prematurely.

Battery swapping systems could be a useful addition to stationary charging. However, the necessary standardization for the interoperability of manufacturers represents a foreseeably large hurdle, which has so far caused this approach to fail in the passenger car sector. Aspects such as an additional space requirement for exchange stations at service stations and in depots as well as the listed disadvantages of the battery sizes carried remain here as well, and additional replacement batteries are also required for changing.

Electric Road Systems (ERS) address these challenges by powering trucks dynamically, i.e. while driving. The influences on logistical processes are marginal, the transport route becomes a **charging route**. The additional space required is small and the spatial and temporal distribution of the loads makes it easier to integrate into the public power grid. The systems have very high overall efficiencies and significantly smaller batteries are needed for the same transport performance [Ram23]. In addition to all-electric ones, hybrid solutions with combustion engines or fuel cells can also be implemented - e.g. as a bridging technology.

ERS are generally conceivable by means of overhead lines, conductor rails or inductively. However, induction coils and busbars require considerable intervention in the road body: construction and maintenance are made more difficult, the service lives of the road and the energy system are mutually dependent and shortened. In addition, the performance and practicality of both systems have not been proven for use in heavy goods transport on motorways. The overhead line, on the other hand, can be integrated comparatively easily into the road space and enables high energy consumption. A full expansion on motorways is not necessary, non-electrified sections of the route can, for example, be covered by the truck's traction battery.

The overhead line shows the greatest ecological and economic potential [Wie17, Bie24, NPM20, ITF22, ITF23, Des23]. Consequently, investments have been made in their testing in Germany: scientifically supported field trials have been running in freight forwarding operations on German motorways since 2019. The findings are promising in all areas. Overhead line systems are thus also tested in heavy traffic. They are non-proprietary, internationally distributed and standardized, diversified supply chains exist. By combining the overhead line system with stationary charging, the decarbonisation of road freight transport is particularly effective, can already be implemented today and can be scaled quickly [Rog24, Ram23, Plö21]. In addition, the overhead line is considered an innovation driver for autonomous driving [Hen22], which will significantly reduce transport costs in the future.

It is time for relevant, trend-setting decisions with a signal effect for Europe and international markets. **The facts speak in favor of the catenary system and the step from field trials to large-scale application**. Schleswig-Holstein, with its surplus of renewable energy, is predestined to tackle the decarbonisation of road freight transport from there.

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