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Author
Sten Wandel, Lund University, Sweden. sten.wandel@tlog.lth.se, corresponding author

Title
Decarbonatization package for long-haul truck transport by bundling electrification, high-capacity transport, and digitalization concepts.

Abstract

Road transport was responsible for 21.1% of the climate gas emissions 2019 and of that cars 12.8%, vans 2.5%, and heavy trucks and buses 5.6% (ACEA 2020). Most scientists agree that electrification of all road transport is the long-term solution, and that biofuels, electric fuels, and fuel cells will serve as bridging technologies.

Since the cost of electrical propulsion is initially higher than for combustion propulsion, subsidies are necessary.

For **cars**: no purchasing tax, cash refund, free or dedicated parking, no road user charges, use bus lanes, drive in zero emission zones, subsidized chargers, and no tax on energy to pay for road maintenance. Some countries have decided to ban selling non-zero emission cars by 2025 or 2030 and ban selling fossil fuels by 2030 or 2045, but not yet such bans for busses or trucks.

Municipalities buys services for public transport from **bus** operators and waste management from garbage truck operators. They can stipulate electric propulsion and let the taxpayers pay for the extra cost. Municipalities can also decide on zero emission zones, which gives a strong incentive to operators of **vans** and **distribution vehicles** to use BEV or hybrid propulsion.

For **long haul trucks**, the extra weight of the batteries reduces the payload, the extra time for loading the batteries reduces the time to get paid for, and the few places for charging makes many potential assignments impossible. One common measure is subsidies for buying electric trucks and chargers. In Germany 80% subsidy of the extra cost. Another is to allow e.g.1 ton more gross weight to compensate for the loss of pay load.

In the parallel, the concept of **High-Capacity Transport** (HCT) is spreading (OECD/ITF 2019 and Wandel & Asp 2021) It consists of the five parts:

- **Roads** adapted for specific High-Capacity Vehicles
- **Vehicle** that are longer or heavier than vehicles allowed for general access and with performance-based specifications (PBS) making them as safe or safer than currently used vehicles
- **Operating** requirements prescribed in **Access Schemes** for how and where to drive these vehicles
- **Digital Framework** to connect all components

- **Legal** and **Institutional Framework,** including **Compliance Assurance Schemes,** for all the above.

HCT 34.5 m has the potential to reduce both cost and energy per ton*km with 27-33% by allowing 34.5 m road trains, e.g. prime mover and two standard EU-trailers (called EMS2), compared to the current 18.75 m allowed in most countries in EU allowing for the standard work horse, prime mover and one standard EU-trailer. (Aeroflex 2021). The extra cost to adapt the roads, longer lanes for left turns, longer parking spaces etc. is very modest, 10-20 million EURO for the main truck routes in Sweden. Higher cost for strengthening bridges if also the allowed gross weight is increased. Current prime movers and trailers can be used after some modifications and often a dolly is added. Finland increased from 60 to 76 ton 2013 and from 25.25 to 34.5 m on all roads if not signed otherwise. Hence, a 34.5 m reform could be implemented within 1-3 years and reduce CO2 27-33%. However, policy makers are concerned that the productivity improvement will lower the price for road transport and by that, reduces the market share of rail and sea transport, so called rebound effects.

By mandating that the HCT vehicles must have zero emission several goals can be achieved. Fewer vehicle*km per ton*km means less accidents if the HCT vehicles are as safe as the vehicles they replace. The HCT vehicle takes up to 50% more payload which partly can be used for batteries, and the rest could be sold to pay for both the batteries and for the charging infrastructure. Thereby, the price of road transport is not reduced, and the modal split is not affected. However, when the cost of electric and diesel trucks become equal, policy instruments are needed to maintain or obtain the desired modal split. For example, a road use charge is introduced to finance the necessary adaption of the road to HCT-vehicles, the charging infrastructure, and the government is compensated for less taxes from fossil fuels, and for subsidies to shift from road to rail and water transport.

As an additional benefit. the high effect chargers along the major trucking routs paid by the HCT operators, can preferable also be used by all other electrical vehicles as cars and busses. Hence, their shifts to electromobility are also accelerated.

The EMS2 vehicle uses 40% less road space and the wear of the road is less compared to single trailer vehicles. This means less time lost due to congestions and it enables postponement of investment in new road capacity and road maintenance.

All this can be achieved at no cost to the taxpayers since the current length and weight restrictions are far from optimal. Optimal is when each road segment is used at its maximal capacity without shortening its life. There are examples that the life of a road can be doubled by using HCT compared to traditional vehicles.

The two concepts electromobility and HCT requires the digitalization concept where vehicles, roads, operators, and charging infrastructures are connected in real time. A reform that bundles the three concepts electrification, high-capacity transport, and digitalization also requires a common legal and institutional framework, including compliance assurance schemes.

The suggested reform package has a very high potential to accelerate a shift away from combustion engines and stimulate new innovations. All stakeholders will gain something from

such reform, which reduces blockages and barrier for its introduction. The speed of introduction could further be increased by converting current prime mower by replacing the combustion engine with an electric engine; axel; or wheel, adding an electric engine in the dolly or trailer, use detachable batteries, and swop instead if charging batteries at stops. It can quickly be scaled up after a few short pilots to find the proper mix of policy instruments, suitable parameters for different contexts, and evolution of parameters over time.

Key words: low carbon road transport, decarbonization, electromobility, smart infrastructure usage, high-capacity transport, access policies, intelligent access, compliance monitoring

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