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Dynamic charging of trucks via overhead catenary enabling sustainable economies

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Abstract

The EU and United Kingdom have enacted legislation to achieve climate neutrality by 2050. This includes the transport sector, which is the only large sector with rising greenhouse-gas (GHG) emissions. For heavy and long-haul road freight various solutions to enable zero emission trucking are being tested. It is becoming more evident that the electrically powered drivetrain of trucks is the most promising option favored by the truck OEM. However, it remains unclear how the energy supply of entire truck fleets can be ensured by the respective infrastructure. Regardless of whether the energy provision is performed by direct electrification or by means of hydrogen three main criteria determine success:

1. Scalability: Quick and large-scale implementation can be ensured by a broad group of industry actors for both infrastructure and vehicles.
2. Usability: It's essential to meet the requirements of the transport operators, being part of a highly competitive industry. Any zero-emission solution for trucks needs to provide the best total cost of ownership (TCO) depending on the use case.
3. Acceptability: The benefits of a zero-emission solution for trucks need to be known and understood both by the public and decision makers. Furthermore, it needs international coordination for the implementation and roll-out to ensure cross-border transport.

This paper will use these three criteria to evaluate the prospect for reaching the climate goals with help of an Electric Road System (ERS) on motorways, based on an Overhead Contact Line (OCL)-for dynamic charging of electrified heavy goods vehicles (HGVs).

Scalability

It is crucial to attract more actors into the field of dynamic charging and the accelerated scaling up of the necessary infrastructure. Considering the scalability of the relevant vehicles, dynamic charging makes it possible to electrify more trucks with the same volume of batteries. A reduction of around 2/3 of a batterie would be feasible with a network covering just the core motorways. Scaling up trucks that can dynamically charge is therefore not a technical issue for the manufacturers, but rather a question of demand.

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Another reason why dynamic charging infrastructure could scale up rapidly is that the number of key stakeholders would be rather small. In many countries one entity controls all the main motorways, so once a decision is made it can be executed quickly.
The OCL solution benefits from a strong supply chain. The global market for rail electrification, which covers the relevant components of overhead contact lines systems and traction power substations, is roughly € 10 billion annually. This allows a quick access to the materials needed and the know-how and the experience related to OCL is already global.

Usability

As an operator of HGV's, it's a matter of economic survival in a highly competitive industry to invest and/or use trucks which provide the best TCO. Dynamic and stationary charging for battery-electric vehicles (BEV's) would enable the direct use of electrical energy and therefore have the highest energy efficiency with a well-to-wheel efficiency of about 73%. Dynamic charging has the additional benefit that it can spread electrical loads over time and space, thus minimizing the impact (and cost) on the electric grid. Dynamic and stationary charging offer the lowest TCO for truck operators. Therefore, to reduce the total investment costs, both solutions should be considered simultaneously to enable a quick time-to-market with fewer Megawatt Charging System (MCS) stations and a dynamic charging backbone to make the transition to electrified trucking faster and cheaper for its users.

The findings from the ongoing field trials in Germany clearly show dynamic charging via OCL for HGV technically works and the HGV receive electric energy high-efficiently while travelling on the motorway. Being in operation and tested since 2019 the solution also demonstrated its climate resilience and reliability. The field trials also have shown dynamic charging technology via pantograph itself is easily integrable in tractor units and the electric energy provided via the OCL from renewable sources is sufficient for traction and recharging the batteries at the same time. The findings of the interim report of one of the field trials in Germany also shows the roll-out of the OCL infrastructure can start now.

Acceptability

The corridors where dynamic charging makes economic and ecological sense, i.e., those with 1000s of trucks passing each day, are quite noisy and polluted. Hence there is a high degree of acceptance of the OCL installations on such sites. Furthermore, the reduced costs of transport benefit the economy, e.g., keeping the cost of goods low, creating opportunities for economic growth rank high with both the public and decision makers, which argues for high acceptability. Also, resource efficiency is enhanced by reducing the dependency on critical materials currently obtained from questionable and/or unreliable suppliers.
Even though studies show that in large countries a national deployment would be economically viable, the benefits of international coordination are strong. Recent studies find that a small coalition of interested neighboring countries is sufficient to kick-start the implementation of dynamic charging of trucks. Also, outside of Europe there is much interest, e.g., China, North America, and India. To facilitate the internationalization and growing acceptance of dynamic charging of trucks using OCL, standardization efforts have been started.

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