Upscaling Electric Freight Vehicles

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FRevue

Issue

The use of Electric Freight Vehicles (EFVs) has not yet been upscaled. This factsheet considers the preconditions and current roadblocks for the upscaling of EFVs.

Solution

Electricity needs to be cheaper than fossil fuels for further freight electrification, so that investment in EFVs can be earned back in good time. Appropriate charging infrastructure is also a precondition.

Charging infrastructure must be upscaled in line with the number of EFVs in use, meaning that timely upgrades in electricity grids and production are necessary. Increased sales of EFVs are needed to push the demand for this infrastructure.

The current generation of EFVs are not commercially viable, but governments can play a role in encouraging their use through subsidies for their purchase, eliminating road tax on EFVs, and making certain emission zones or time windows EFV-only.

Results & Benefits

- A steady growth in the number of EFVs, leading to more pertinent data
- Planning tool developments
- Standardisation and installation of fast charging infrastructure supported by a smarter and improved electricity grid
- A growing number of EFVs will create more confidence and more experience around the use of EFVs by drivers, maintenance personnel and planners

Context

Large electric freight vehicles are currently only available through retrofitting companies and are at least twice the price of conventional counterparts. Making operational costs lower will mean that EFVs are cheaper to own over their lifetime, despite the up front cost. Costs can be lowered through cheaper energy and maintenance.

There is considerable uncertainty about how much batteries will cost in the next few years, but economies of scale are expected to have a significant impact on battery prices.

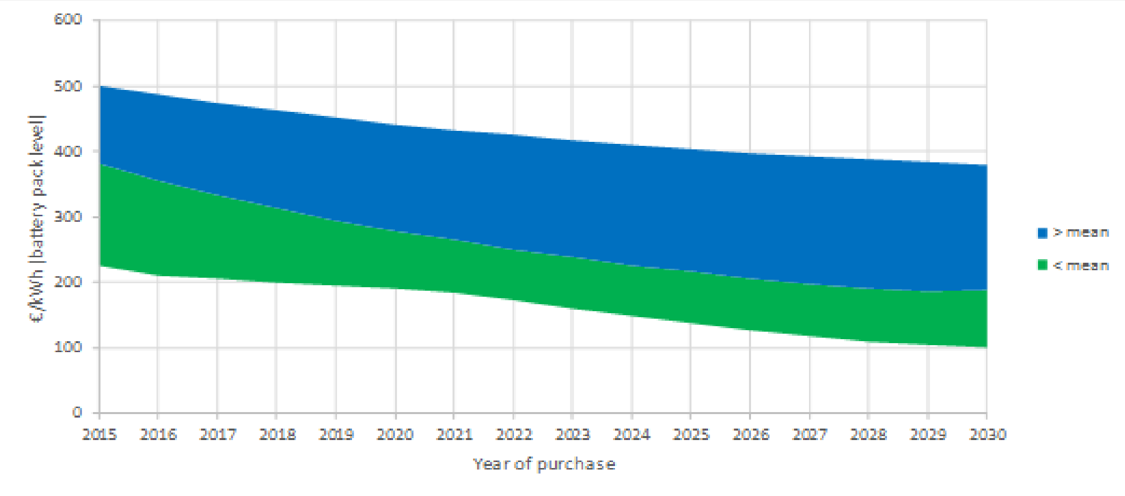

Figure 1. Bandwidth of reported prognoses of battery prices in literature

The lifetime of batteries will grow, with an expected increase in charge cycles from 3000 in 2016 to 5000 in 2024, which will reduce the total cost of ownership.

Energy cost per kilometre is key for determining whether the total cost of ownership is lower for an EFV than a conventional one. Tables 1 and 2 show these costs for EFVs and diesel equivalents, including the bare electricity price, transport costs, grid connection costs and the presumed depreciation, plus maintenance costs of the charger.

	Year								
	2016	2017	2018	2019	2020	2021	2022	2023	2024
Slow charging (€/kWh x3)	0.423	0.438	0.450	0.465	0.477	0.489	0.498	0.510	0.519
Fast charging (€/kWh x3)	0.555	0.570	0.582	0.597	0.609	0.621	0.630	0.642	0.651
Diesel (€/l)	1.062	1.100	1.130	1.167	1.198	1.228	1.250	1.280	1.303

Table 1. Projection of expected average electricity and diesel prices

These costs differ within Europe. In Sweden the electricity price is 0.06 €/kWh, ex. VAT, compared to 0.24 €/kWh, ex. VAT in Germany, which means the total cost of ownership of an EFV will differ between countries. This is also true, however, for conventional vehicles, due to differing diesel prices across the continent.

When regarding fuel costs, the vehicles used in the FREVUE project used 3.5 kilowatt hours to travel the same distance that diesel-powered vehicles would cover with one litre of diesel, meaning that if the cost of 3.5 kilowatt hours is lower than the cost of one litre of diesel, the EFVs would be cheaper to fuel than equivalent diesel vehicles. Another factor to consider is the number of kilowatt hours that a battery can provide over its lifetime, as the longer this time is, the lower the overall operational costs will be, due to savings on the purchase of new batteries. This is known as the depreciation cost.

Once EFVs are produced on the same scale as diesel equivalents, the material cost of production should be a similar level for both, not including the battery pack. For mass uptake of EFVs, it is therefore important that the price of the battery pack decreases over time.

Table 3 shows the expected purchase prices for converted and in-series produced EFVs in 2019 and the mileages required to earn back the corresponding extra investment in the EFV (compared with a conventional freight vehicle (CFV)).

Vehicle class	Expected purchase price difference						Required mileage for TCO conventional = TCO EFV (km)					
	Converted EFV			Series EFV			Converted EFV			Series EFV		
	Slow charging	1x fast charging	2x fast charging	Slow charging	1x fast charging	2x fast charging	Slow charging	1x fast charging	2x fast charging	Slow charging	1x fast charging	2x fast charging
<3.5 tonne	46,000	40,000	37,000	15,000	9000	6000	69,7000	666,000	652,000	233,000	145,000	105,000
13 tonne	111,000	97,000	91,000	32,000	18,000	12,000	805,000	787,000	779,000	233,000	145,000	106,000
19 tonne	159,000	142,000	136,000	38,000	21,000	15,000	980,000	984,000	985,000	233,000	145,000	106,000

Table 2. Mileage for earning back the investment in an EFV (battery pack: 278 €/kWh)

The table shows unfeasibly high mileages are needed for converted EFVs to become cost efficient, but for series produced EFVs, the mileage needed would fall within acceptable limits. There is a paradox in that higher mileages result in shorter depreciation, and therefore higher cost efficiency, but this would mean a larger, more expensive battery, and this would lead to longer depreciation times.

Purchasing EFVs that are to be used for shorter trips is currently the most practical use of EFVs, as there are more opportunities to recharge them during the day.

There is uncertainty over when mass-produced EFVs will become available, but Mercedes have announced that they plan to release a heavy electric lorry in 2020. Due to the uncertainty over the best time to buy, there is a risk of stagnation in the EFV market while potential buyers postpone their purchase. This could have a knock-on effect on the development of charging infrastructure, and it would be undesirable to see a slowdown in this infrastructure being developed.

Lessons learnt & Recommendations

The impact of diesel and electricity prices will have a big impact on the level of cost advantage of EFVs over CFVs. Energy prices differ across Europe, due to taxes and rates set by government. Freight operators with a large fleet who pay low electricity rates are likely to be the first to transition to electric freight, as they can organise fast charging infrastructure internally.

As all current large EFVs are converted from conventional lorries, there is a high initial cost that makes the total cost of ownership higher than that for a conventional equivalent unless the vehicle is driven between 650,000 and 1,000,000km. This means there is currently not a good business case for large EFVs.

On the other hand, as long as there are no in-series produced EFVs on the market, the use of these converted EFVs is important for:
1) gaining experience with integrating EFVs in daily fleet operations, which is especially important if fast charging needs to be well-planned (often planning software needs to be updated in order to support this in an efficient way)
2) gaining experience with suppliers of charger equipment and electricity grid operators
3) Standardising automated charger equipment
4) gaining experience with maintaining EFVs, which requires different skills, tools and safety standards
5) gaining confidence in the capabilities of EFVs, which is especially important for future drivers and planners
6) Building confidence with charging equipment manufacturers and potential EFV manufacturers that electrified freight transport will take off in the near future.

Further information

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