The suitability of electric freight vehicles for urban logistics

Issue To demonstrate the operational feasibility of electric freight vehicles in eight of Europe's largest cities

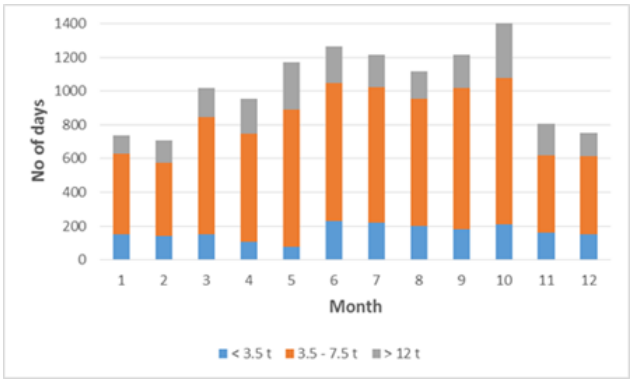
Solution The collection and analysis of operational data

Results The electric vehicles that were deployed have proven technically and operationally suitable for most urban logistics operations

Context

Static and dynamic vehicle data were collected from more than a hundred electric freight vehicles across the FREVUE demonstrator cities. Gross vehicle weights ranged from 2.2 t to 19 t, and battery capacities from 22 kWh to 200 kWh.

The data collection period spanned from early June 2014 to mid-November 2016, and the 77 vehicles included in the detailed analyses covered 12 366 days of operation and a total mileage of 757 000 km.



Results - Key performance indicators

Energy spent per day or per km is, as expected, strongly related to gross vehicle weight. On average, these indicators are around four times higher for the large vehicle group compared to the small vehicle group.

We have no information about the load carried by the vehicles, but energy spent per gross vehicle weight and km driven can be computed. This proxy indicator shows that the large vehicle group is potentially as efficient, or even more so, as the other vehicle groups.

Weight group	Energy spent per day (kWh)	Energy spent per km	Energy spent per tonkm	Km per kWh	Average range (km)
< 3.5 t	16.2	0.23	0.12	4.8	106
3.5 - 7.5 t	23.0	0.65	0.11	1.9	115
> 12 t	60.6	1.01	0.07	1.1	170
Average	**29.0**	**0.65**	**0.10**	**2.2**	**124**

Km per kWh decreases with vehicle weight, and the average range (km) increases with vehicle weight and battery capacity.

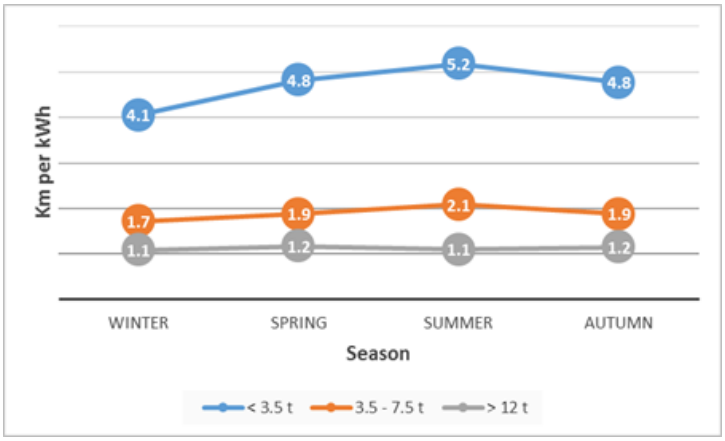
The effect of time of year on vehicle operation

Km per kWh

It is well-known from the literature that the efficiency of electric cars is negatively affected both by extremely cold and extremely hot weather, but does the same apply to EFVs?

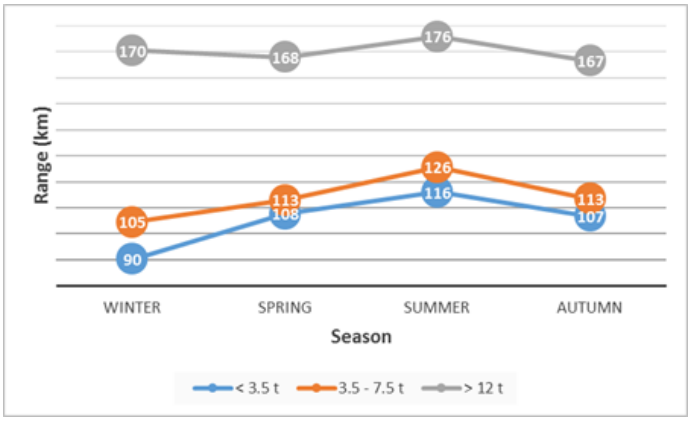
The FREVUE data allow us to examine this question empirically. The figure shows how the average performance, measured as Km per kWh, varies by time of year for the three weight groups.

For small vehicles the average efficiency is 27% higher during summer compared to winter. For medium-sized vehicles there are small improvements in efficiency as the season changes from winter, to spring and then summer. For large vehicles, the average efficiency is about the same throughout the year.



Range

A related question is whether the effective range of vehicles is affected by seasonal variations in temperature.



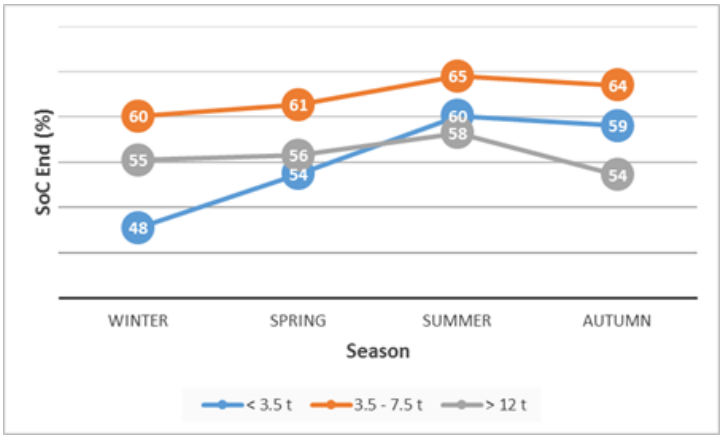
The smaller vehicles have distinct and logical variations in range depending on the season. The ranges during spring and autumn are almost identical, and the ranges during summer compared to winter are 29% longer for the small vehicles and 20% longer for the medium-sized vehicles. The range of the largest vehicles is also longest during summer, but in general they are not affected to the same degree by season.

State of charge

One of the ways that operators can adapt to the fact that vehicles may have a lower range when the weather is cold is to take more energy out of the battery, so that the state of charge (SoC) is closer to zero at the end of the day.

The figure shows that all vehicle groups have their lowest average SoC at the end of the day during winter and their highest SoC at the end of the day during summer. This pattern is most distinct for the small vehicles and less distinct for the large vehicles.

This seems to indicate that operators are able to perform the same type of logistics work, independent of season, by taking more or less energy out of the battery before the end of the working day.



Lessons learnt & Recommendations

• The electric vehicles deployed as part of FREVUE are technically suitable for logistics operations

• Some small and medium-sized vehicles have limited range, and may need fast charging during the working day

• Most large vehicles seem to have excess battery capacity for the logistics operations they are currently performing

• The building of inner city fast charging infrastructure and new battery packs with higher capacity will further remove barriers for the operation of EFVs in cities

• There is some uncertainty about the effects on local grid capacity when battery sizes increase

Further information

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More information: Publishable Executive Summary of D3.1 Technical Suitability of EVs for Logistics.

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