Environmental benefits of running EFVs

Imperial College London

FRevue

Issue

To understand, quantify and monetise the environmental benefits of replacing conventional diesel trucks with electric freight vehicles, both at the project level and a wider uptake level.

Solution

Implemented emission calculation, transport modelling and emission valuation.

Results & benefits

Electric vehicles deployed as a part of the FREVUE project have produced environmental benefits, even at the average carbon intensity of electricity generation during the project. If a higher EFV market penetration is achieved, a substantial level of air pollutant reduction and GHG savings are expected, along with significant economic benefits.

Context

Road freight transport delivers many benefits to our society. It allows the movement of goods and services, supports economic growth and provides employment opportunities. However, despite these benefits and significant progress of technological and efficiency improvements over the years, road freight transport is a major contributor to greenhouse gases (GHGs) and air pollution. These negative impacts result in a deterioration of both human health and the environment, and thereby cause significant economic costs to our society.

Electric freight vehicles (EFVs), which have zero emission at the point of use, could be an answer to the air quality problem and GHG emission in city logistics. As a part of the FREVUE assessment framework, analysis was carried out to measure, analyse and quantify the environmental impacts of the demonstrators from running electric freight vehicles (EFVs) instead of using conventional internal combustion engine vehicles (ICEVs).

Method

The analysis was carried out at three levels: the first level looked at direct environmental impact quantification from FREVUE demonstration activities. The second level examined potential environmental impacts at different EFV penetration levels to address the issue of small-scale deployment of EFVs. The third level analysis aimed at monetising the wider systemic and environmental benefits, which should help for a better understanding of the overall impacts of current and future implementation of EFVs and may also be used for setting out new policies to encourage future uptake of EFVs.

Results

Direct impact analysis

The first level analysis compared EFVs with different ICEV technologies (or emissions standards). Assuming all vehicles have a load factor of 50% and no load reduction as a result of electrification of the fleet, it is shown that over the whole period of project demonstration activities, the FREVUE demonstrators brought NOx savings of 2147.5 kg and total PM10 savings of 72.2 kg if replaced ICEVs are assumed to be Euro 3/III vehicles. This is equivalent to total road transport NOx emissions in the City of London for three days in 2013 and total road transport PM10 emissions in the City of London for two days in 2013. If the baseline ICEVs are newer Euro 6/VI vehicles, the overall benefits from FREVUE demonstrations amount to NOx savings of 628.6 kg and PM10 savings of 1.4kg. There is a significant reduction in benefits when comparing Euro 6/VI to Euro 3/III results, due to better performance and improvements of emission control technologies used in the newer vehicles. In the FREVUE project, most replaced ICEVs were either Euro 3/III or Euro 4/IV. The overall direct benefits are therefore very significant.

GHG emissions are not directly related to emission standards. Our analysis shows that the local GHG savings are between 385 and 400 tonnes CO2e, and the total GHG environmental loads, using well-to-wheel analysis, are between 176 and 190 tonnes CO2e. This represents an overall saving of 45 percent and is equivalent to total road transport GHG emissions in the City of London for about one day in 2013.

Impacts at wider uptake levels

The second level analysis looks at potential environmental impacts at different EFV market penetration by using traffic models. Two models have been obtained from FREVUE demonstration cities, including the LoHAM model from London and the VMA model from Amsterdam.

Results from the level two analysis show that in the year 2021 within the M25 area in London, by using the ICEV fleet composition forecast provided by Defra, the benefits from electrifying goods vehicle fleets under the low penetration scenario that 10% of all freight conventional vehicles are converted into electric vehicles have a maximum achievable:

- CO2 savings of 2.8 million tonnes per year
- NOx savings of 402 tonnes per year
- Exhaust PM10 savings of 3.8 tonnes per year

The benefits for medium (50%) and high (100%) penetration levels are much higher.

In the year 2031, due to a wider deployment of the Euro VI/6 vehicles with better emission control technologies, the NOx and PM10 reductions are smaller compared to 2021 results under similar penetration levels, with 2489 tonnes and 16.8 tonnes savings per year respectively within the M25 area for the high penetration scenario. The CO2 maximum achievable emission savings, however, increase to 2.9 million tonnes per year due to higher vehicle mileages are predicted by traffic models.

Impact monetisation

The third level analysis estimates the monetary values from air quality improvements and GHG reductions. Only London is analysed due to the availability of key parameters. It is calculated that at the low penetration level for the year 2021 (10% uptake levels), using central value scenario (the most likely scenario), the total benefit discounted to 2017 price from air quality improvement based on damage cost reduction is 0.3 billion pounds, and total benefit from GHG savings is 13.5 million pounds at the 2017 price. In year 2031, the benefits of air quality improvement for a high penetration level are expected to reach 1.8 billion pounds, and the benefit of GHG savings is valued at 184 million pounds at the 2017 price.

Lessons learnt & Recommendations

- Environmental benefits of deploying EFVs, especially the reduction of air pollutants, are directly linked to the type of vehicles to be replaced. For example, replacing a Euro III/3 will generate much larger benefits than replacing a Euro VI/6 vehicle.

- The reduction of GHG emissions depends strongly on the carbon intensity of the local electricity grid. However, as the power sector is gradually decarbonised, the well-to-wheel GHG savings are likely to improve.

- Analysis on the transport models show that light goods vehicles (LGV) penetrate much more deeply into local traffic network than heavy goods vehicles (HGV). Therefore, electrification of LGVs would potentially bring better results for reducing negative health impacts.

- If even a small percentage of existing urban logistics fleet is electrified (e.g. 10%), it would bring significant reduction of harmful pollutants with significant economic benefits

- When calculating emission savings based on traffic models, or monetising the environmental impacts, we should recognise that there are substantial uncertainties in these cost estimates due to significant uncertainties regarding lags between action and effects.

Further information

FREVUE Coordinator: Tanja Dalle-Muenchmeyer
tdmuenchmeyer@westminster.co.uk

FREVUE website: www.frevue.eu

Yanjie Dong
y.dong13@imperial.ac.uk

The FREVUE project has received funding from the European Union’s Seventh Framework Programme for research, technological development and demonstration under grant agreement no 32162