A simulation-based study of a proposed road freight electrification system demonstrator in the UK

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Abstract

In its sixth Carbon Budget, the UK set into law a target reduction of greenhouse gas (GHG) emissions of 78% by 2035 relative to 1990 levels [1], and reaffirmed its dedication to net zero emissions by 2050 [2]. This is one of the world's most ambitious decarbonisation targets. By sector, transport is the largest contributor to GHG emissions in the UK accounting for 27% of emissions, and of this road transport carries the biggest share of 91% [3]. Heavy Goods Vehicles (HGVs) are particularly over-represented, accounting for 16% of road transport emissions while contributing 5% of vehicle kilometres travelled [3].

While full battery electric vehicle technology seems set to become the de facto solution to decarbonise passenger vehicles and light to medium-duty goods vehicles, long-haul heavy-duty road freight transport remains a difficult-to-decarbonise sector. This is primarily due to the high energy, power and range demands of HGVs, and the limitations around the mass, energy density, and charging rate of current battery technologies. Consequently, the UK Department for Transport (DfT), together with funding agency Innovate UK, funded several feasibility studies into zero emission road freight demonstrators, including an 'Electric Road System' (ERS) demonstrator [4] and a hydrogen fuel cell vehicle demonstrator [5].

A consortium comprising Costain, Siemens, Scania, The Centre for Sustainable Road Freight, NPL Power Lines; Arup, Possible, Box Energy, Milne Research and others has been successful in obtaining funding to examine the feasibility of a project that will demonstrate all aspects of electrification of the UK road freight system, based on the Siemens 'eHighway' ERS system [6]. The eHighway comprises roadside infrastructure of overhead electric cables and compatible electric trucks with deployable pantograph systems. Such a system enables the trucks to be powered directly while also charging relatively small on-board battery packs which provide sufficient operating range off the ERS network. Initial studies indicate that ERS is the lowest cost, lowest energy, lowest carbon solution for obtaining net zero HGVs in the UK by 2050 [7].

For the UK ERS demonstrator, it is proposed that the Siemens eHighway system be installed along a section of the M180 motorway between the A156 and the M18 in North Lincolnshire, UK. This section of motorway connects the ports at Grimsby and Immingham to several national distribution centres near Doncaster, and consequently carries significant HGV traffic.

This paper will present a simulation-based analysis of the freight electrification demonstrator. An analysis of logistics data for UK freight operations will be presented and a number of representative logistical scenarios will be defined. These scenarios will then be tested using a simulation model of the electric lorries and charging infrastructure against a range of variables, including the length of ERS installed, vehicle battery capacity, vehicle charging rates on the ERS, and the availability of static chargers located in the logistics facilities. The results of the study will help to inform the specification of both the vehicles and infrastructure needed for the demonstrator and will support future studies into the design and energy needs of a national UK road freight electrification system.

References

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