Objective

Commercial vehicles including home delivery vans and buses account for 34% and 39% of UK transport related CO2 and NOx emissions. One way to decarbonise this sector, is via electrification of the fleet.

Electrification is not straightforward, variable demanding duty cycles conflict with limited vehicle ranges and power availability constraints on when charging can take place. Therefore, granular consideration of vehicle duties at an individual vehicle level rather than fleet averages is required to achieve optimum economics. For this study, 42,000 unique home delivery operator journeys were considered. The potential for vehicle to grid (V2G) has also been assessed for retail stores.

Methodology

Data Processing & Structuring → Vehicle Allocation → Charging Script → Costs & Emissions → Load Profiles

Vehicle Utilisation

Individual journeys for each vehicle operating from a store were assessed. A variety of vehicle allocation methods were used to explore the number of vehicles required to meet demand at each of the stores and depots under consideration. Constraints like range and charging windows were applied to explore the impact on number of vehicles required by operators.

The investigation of vehicle allocation also enabled us to examine utilisation rates of individual vehicles. This highlighted the possibility of using mixed fleets as a mechanism of reducing cost and improving flexibility.

Costs & Emissions

The vehicle allocation and journey patterns were used to determine the annual costs for each individual vehicle and store using a set of cost factors agreed with industry. It is evident from Figure 4, that thought the total costs vary depending on the vehicle type chosen, purchase and driver costs are dominating factors in the vehicle economics. In terms of emissions, diesels are more polluting than EVs. However, Renault Master ZE leads to a slightly higher emissions than LDV80 since its range constraint requires the use of additional diesel vehicles within the retail operations.

Potential for V2G

The potential for V2G varies from store to store and depends on the journey patterns for each vehicle. From Figure 7, it is clear that reserving 20% of battery pack capacity for V2G does not impact the store operations. However, reserving 40% for V2G, leads to additional vehicle requirements in order to avoid any disruption to journey patterns. Since vehicle purchase and associated personnel costs are significant for vehicle economics (and a multiple of what is available from modelled V2G revenues), this additional vehicle requirement will offset any economic benefit from V2G for the retail store.

Conclusion

- Most of the journeys (>60%) in the data could be electrified with good charging strategies.
- With reorganization of vehicle tasks more than 89% of the journeys can be done using EVs such as LDV80.
- Vehicle purchase and personnel costs are the most significant factors for vehicle costs suggesting that strategies that minimize this are more important than accessing cheap electricity.
- A mixed fleet approach would help reduce the total costs since vehicle utilization rate varies for each vehicle.
- Electrical load profiles indicates the electrical capacity required at a store as well as the associated connection costs incurred. To avoid peak electricity prices, opportunity charging during shifts needs to be explored within vehicle operations (work in – in progress).
- V2G with 20% capacity reduces the total annual cost. However, the benefit from V2G is offset sometimes by the increase in the operating cost due to greater number of vans required to complete the journeys. The total annual cost increases further, when 40% of battery pack capacity is assigned to V2G.
- The tools developed for this project can be used on large and complex data sets in future projects.

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