Electrification of Home deliveries Fleets

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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 straight forward, 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

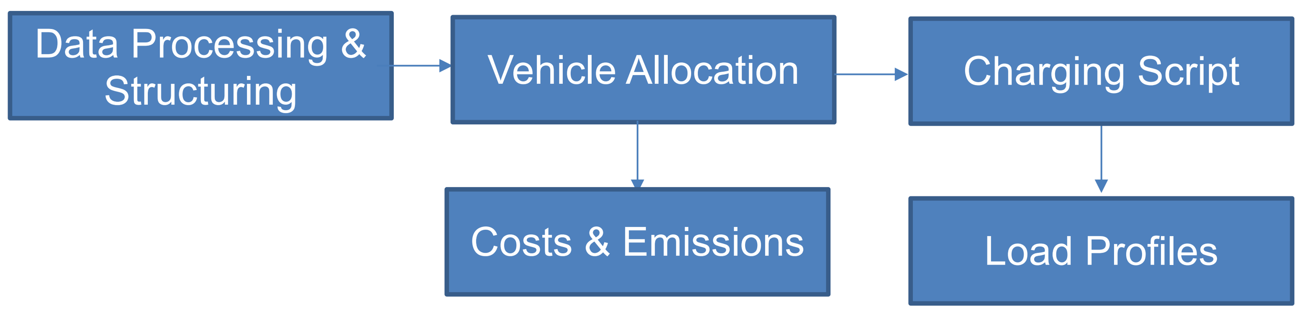

Figure 1: Methodology

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.

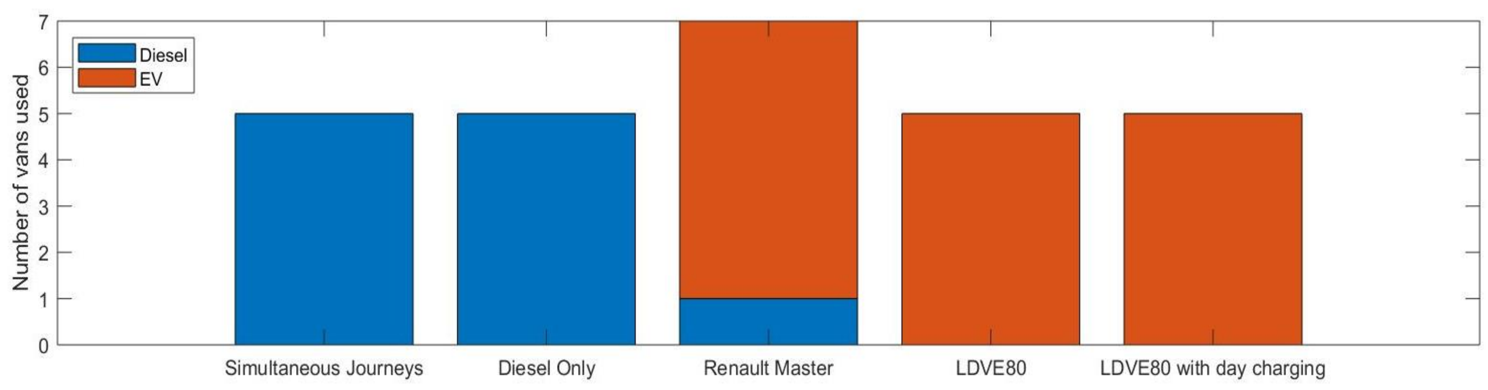

Figure 2: Vehicles required for different vehicle types

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

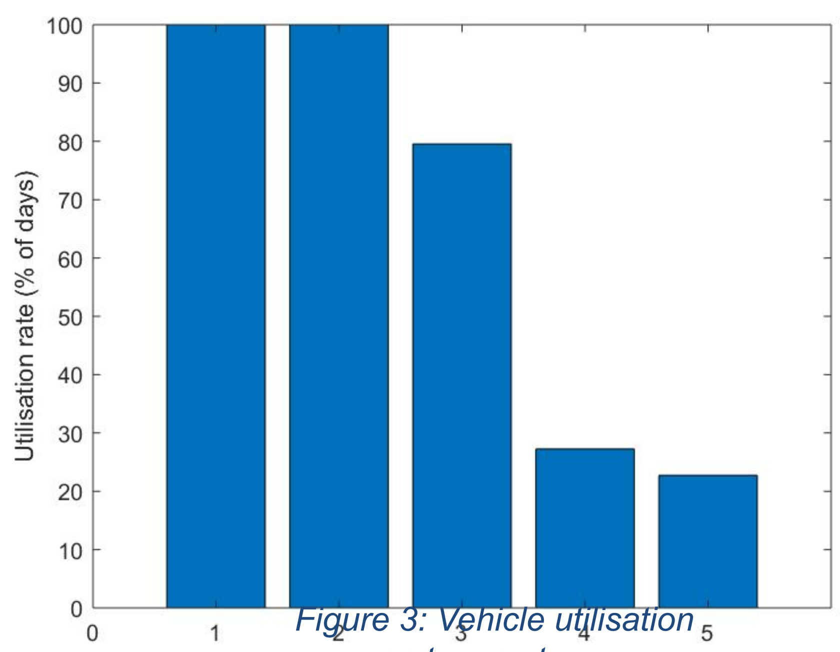

Figure 3: Vehicle utilisation rate per store

Costs & Emissions

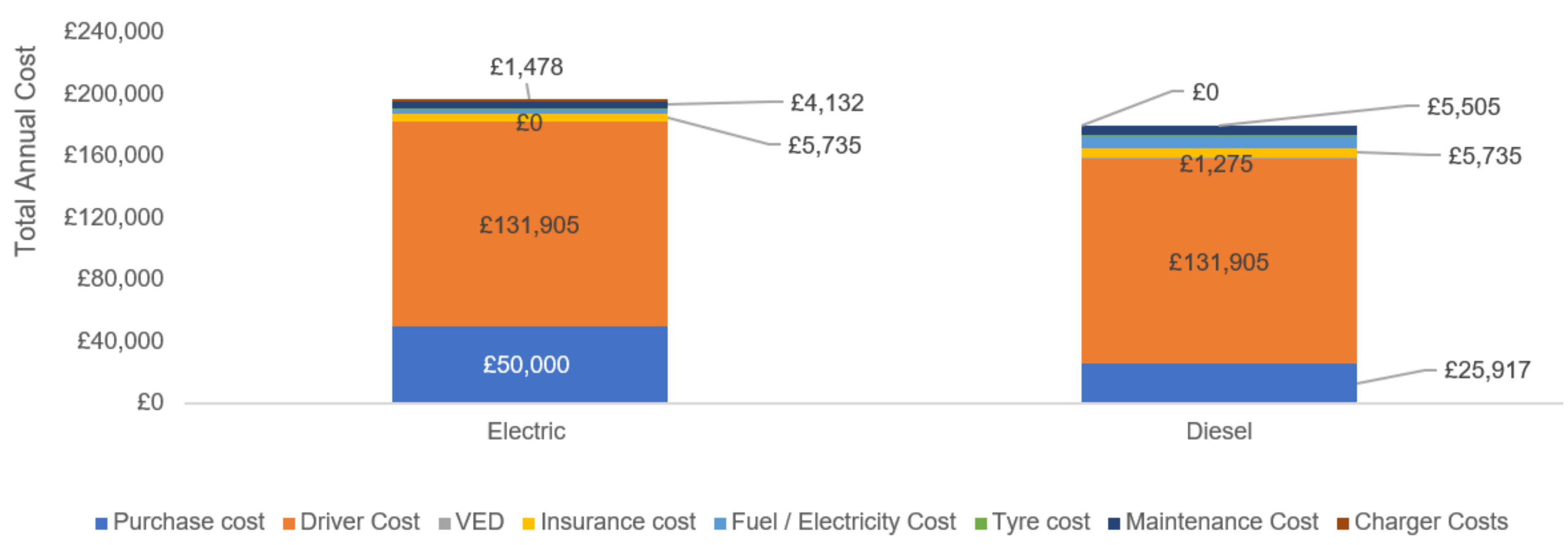

Figure 4: Annual Store Costs

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 EV. However, Renault Master ZE leads to a slightly higher emissions than LDVE80 since its range constraint requires the use of additional diesel vehicles within the retail operations

Vehicle Charging Load Profiles

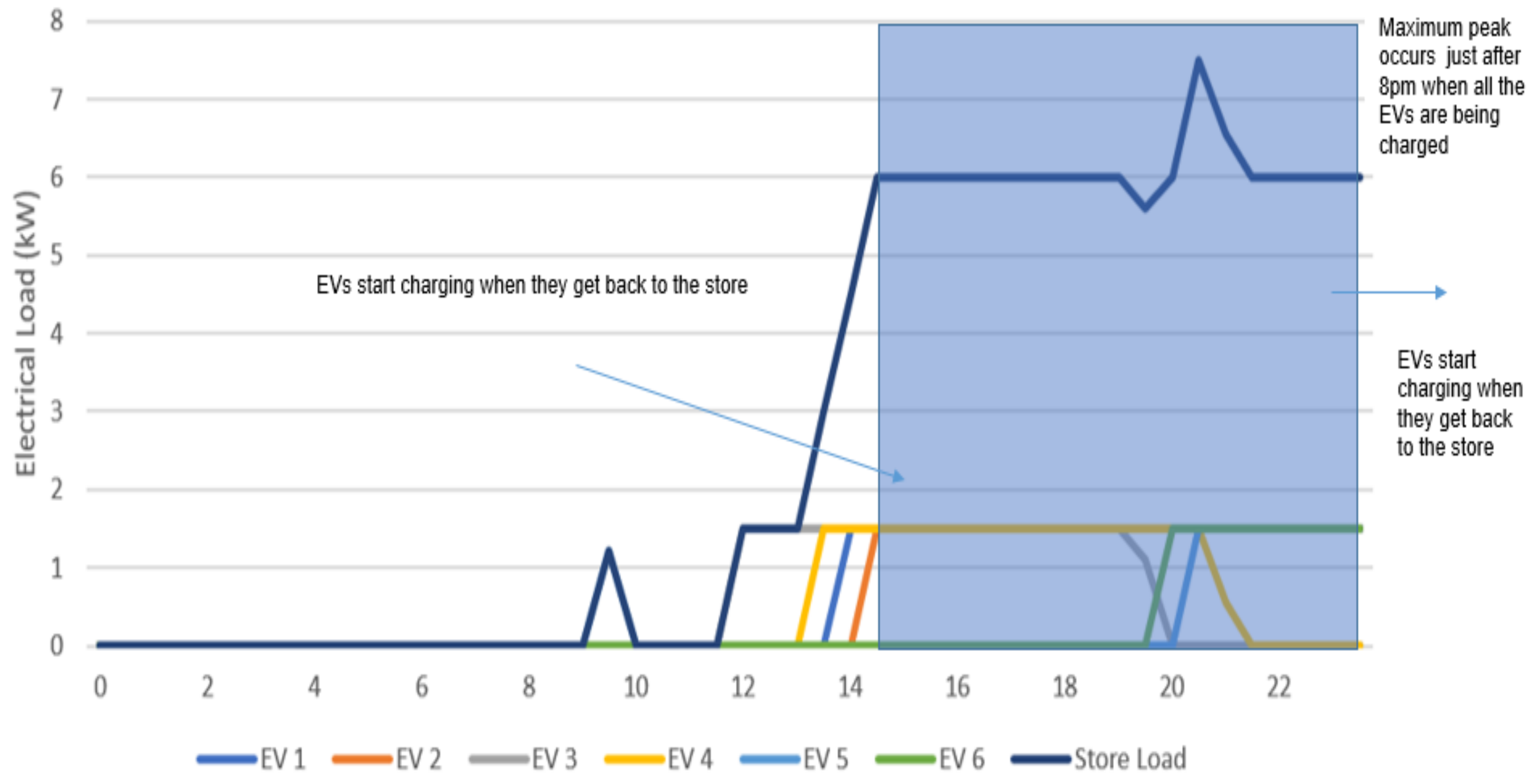

Figure 5: Electrical Load Profile for a store

Individual vehicle duties across the review period were used to estimate the vehicle energy consumption and thus the charging requirements in some detail. Vehicle duty cycles also dictate when charging can take place. Figure 5 provides an indication of an average day of unmanaged charging.

The vehicle journey patterns are also useful to determine when the vehicles are at the depot. It can be observed from Figure 6, that at least one vehicle is available at the depot at all times, indicating that this vehicle is used to account for the spikes in orders. Return times across the day are calculated to identify potential for both opportunity charging and V2G.

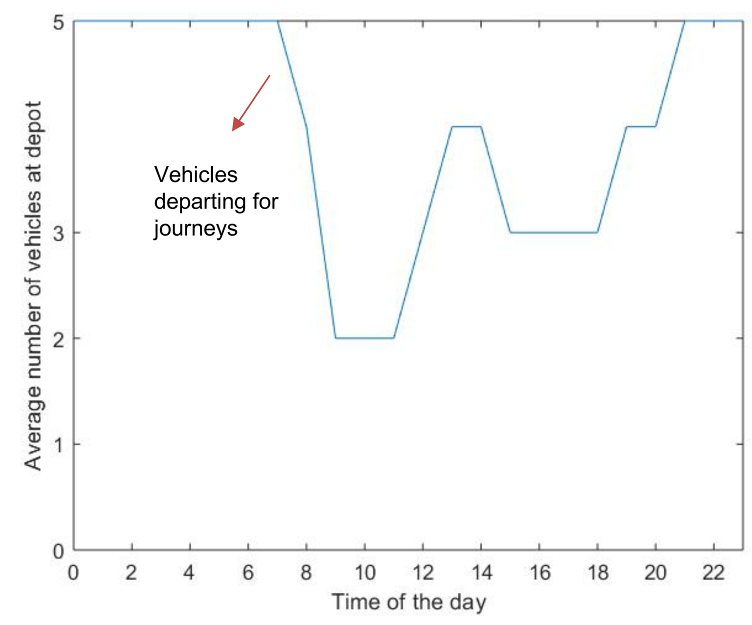

Figure 6: Vehicles at store

Potential for V2G

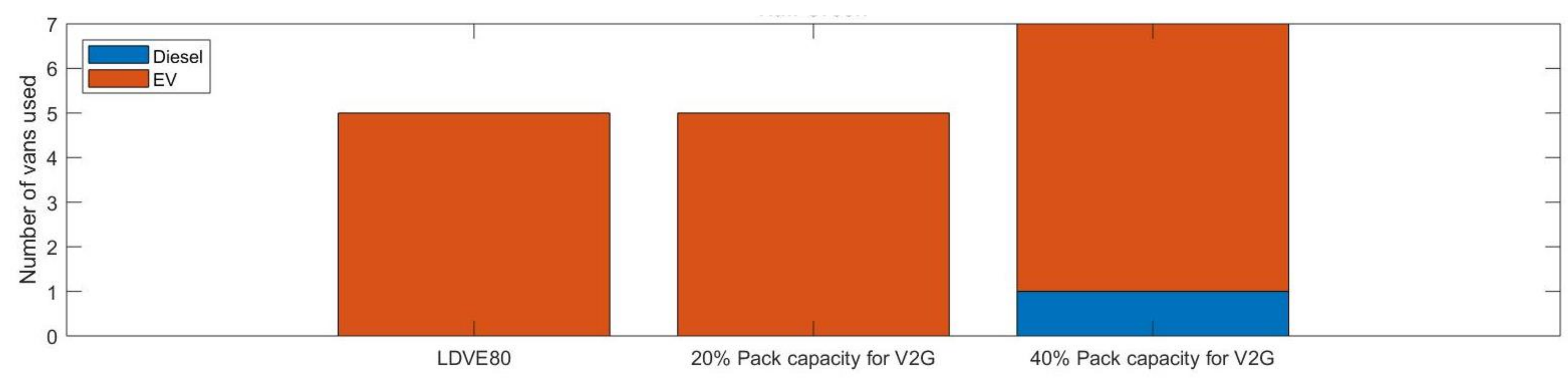

Figure 7: Effect of V2G

The potential for V2G varies from store to store and depends on the journey patterns for each store. 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 LDVe80
- 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 explored within vehicle operations (work – 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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