MAYOR OF LONDON

Mayor of London / Gnewt Cargo Electric Vehicle Trial

Final Data Analysis Report

November 2019

Innovate UK

gnewt BY MENZIES DISTRIBUTION

Data Analysis Partner:

ARUP

COPYRIGHT

Published by
Greater London Authority
City Hall
The Queen's Walk
More London
London SE1 2AA
www.london.gov.uk
enquiries 020 7983 4100
minicom 020 7983 4458
ISBN

Copies of this report are available
from www.london.gov.uk

CONTENTS

Executive Summary

The Mayor of London / Gnewt Cargo trial project (July 2017 to December 2019), examines the performance of a set of innovative electrical vehicles (EVs) used for delivery and logistics purposes in London.

The project is divided into the following reports:

- Baseline Report
- Operational Costs and Environmental Benefits
- Key Barriers Report
- Charging Infrastructure Grid Report
- Q1 Environmental Update Report
- Q2 Environmental Update Report
- Q3 Environmental Update Report
- Q4 Environmental Update Report
- Q5 Environmental Update Report
- Q6 Environmental Update Report
- Q7 Environmental Update Report
- Operational Costs and Environmental Benefits refresh
- Charging Infrastructure Grid Report refresh
- **Final Data Analysis Report**
- Final Report

This report concentrates on the analysis of data collected from the Fleetcarma telematics system over the trial of larger[1], modified EVs of a comparable size to diesel vans. The telematics system records data (e.g. distance travelled etc) directly from a tracker positioned in the vehicle enabling analysis for operations teams (see Data Collection section for more details)

Analysis of data collected over a two-year period revealed some key insights.

- Trial EVs consumed less energy (MJ/100 km) than the diesel vans to travel the same distance:
    - Nissan NV200 diesel vans use five times more energy than Nissan trial EVs (Voltia and Vic Young); and

[1] EV fleets tend to comprise purpose built small cars and vans (max. 3.5 tonnes). There is limited production of larger electric vans such as those comparable to the Mercedes Sprinter (capacity 8.5m^3/ payload 1,035 kg).

  - Fiat Ducato diesel vans use 3.5 times more energy than the BD Auto eDucato trial EV.
  - The Voltia and the Vic-Young vehicles consume less energy than the small EVs (shown in Figure 1). This is likely to be because the trial EVs are newer models with more efficient powertrains than the existing fleet.

- Trial vehicles covered longer distances (178km per week) than the smaller EVs (140km per week) and delivered more parcels (123-140 parcels per week compared to the small EVs at 92 parcels per week). This shows the potential for operational benefits to fleet operators if larger vehicles were adopted on a wider scale. Larger payload capability results in a reduced frequency of return trips to the depot for reloading. The longer distances covered are likely due to the transport planners routing the trial vehicles to cover longer routes whilst the smaller vans cover routes closer to the depot due to needing to reload. This enables a more efficient operation (drivers out for longer, depot staff not required to aid reloading, clearer depot as all parcels loaded) and potential to deliver a greater number of parcels maximising the driver's time on the road.

- On average, the vehicles left the depot with 92% charge and after a full working day arrived back at the depot with 62% charge remaining. This allays any range anxiety concerns for operators considering similar vehicles for last mile deliveries in an urban environment.

Introduction

This report summarises the final data collected for the Mayor of London / Gnewt Cargo electric vehicle trial project (see Background section for project background). It details the findings of analysis conducted on data collected from vehicles operating within the Gnewt Cargo fleet.

The Gnewt Cargo fleet consists of the trial EVs and smaller EVs. In 2017 two additional diesel vehicles were hired and operated to establish a baseline for comparison. The focus of this report is a comparison of the trial EV data gathered between November 2017 and September 2019 with the performance of the smaller EVs and the diesel vehicles. The data collected enabled analysis and review of several logistical, environmental and economic key performance indicators (KPIs).

Detailed insight into the operation of the diesel vehicles can be found in the Baseline Data Report.

In later sections of the report, comparisons will be made between:

- the larger trial EVs and smaller EVs
- the trial EVs and (near) equivalent diesel vehicles.

Table 1 below provides a brief introduction to and comparison of the EV types deployed during this trial.

Table 1 Trial fleet EV comparison table

Vehicle Information	Trial EVs		
	BD Auto	**Nissan – Vic Young modified eNV200**	**Nissan - Voltia eNV200**
			
Make	BD	Nissan – Vic Young	Nissan - Voltia
Model	BD Auto	eNV200 (Vic Young modified)	eNV200 (Voltia modified)
Overall dimensions – length / width / height (mm)	5998 / 2050 / 2522	5195 / 1800 / 2400	5030 / 1760 / 2420
Gross weight (kg)	3500	2220	2000
Payload volume (m3)	13	7.5	8.0
Battery Size (kWh)	62	40	22

Table 2, below, provides a brief introduction to and comparison of the smaller (non-trial) EVs and diesel vehicles deployed during the trial.

Table 2 Diesel and smaller EV comparison

Vehicle Information	Diesel		Electric	
	Fiat Ducato	**Nissan NV200**	**Renault Kangoo**	**Nissan eNV200**
				
Make	Fiat	Nissan	Renault	Nissan
Model	Ducato 35 Multijet	NV200	Kangoo Z.E.	eNV200
Overall dimensions – length / width / height (mm)	4693 / 2050 / 2254	4400 / 1690 / 1860	4282 / 2138 / 1844	4560 / 1755 / 1858
Gross weight (kg)	3000	2000	2146	2220
Payload volume (m^3)	8.0	4.2	3.4	4.2
Emissions standard	Euro 6	Euro 6	N/A	N/A

Background

The Mayor of London / Gnewt Cargo Ltd project, examined the impact of larger EVs used for delivery and logistics purposes in London using a range of logistical, environmental and economic performance factors. Gnewt Cargo specialises in delivery of goods using electric, low emission vehicles.

At present, EV fleets are often comprised of purpose-built small cars and vans (max. 3.5 tonnes). There is limited production and uptake of larger electric vans such as those comparable to the Mercedes Sprinter (capacity 8.5m³/ payload 1,035 kg). This project seeks to examine the benefits/disbenefits of the introduction of larger EVs to London roadways.

The establishment of a baseline was the first phase of the project; it was designed to allow comprehensive monitoring and evaluation of the impact of the trial EVs during the trial. These were measured in terms of:

- vehicle viability and reliability
- evaluation of charging infrastructure
- assessment of the impact of larger EVs and different charging approaches/technologies on the grid.
- Quantification of the business opportunities for scaling up the project

To establish the baseline, Gnewt Cargo Ltd hired two Fiat Ducato diesel vehicles (see Table 2) and fitted a Fleetcarma fleet telematics system (more on this in the next section). These vehicles were operated from 1st August to 15th September 2017 and completed deliveries across London, including: Tottenham Court Road / Goodge St. / Fitzrovia, Liverpool St. / Moorgate. These locations were considered to provide a representative sample of different business areas due to their varied characteristics, levels of congestion and building types.

An additional phase of baseline testing was conducted by LowCVP[2] in September 2019. This test-track based simulation used a Nissan NV200, fitted with the same Fleetcarma data trackers and replicating typical Gnewt delivery cycles.

The baseline routes were replicated during the second phase of the trial, which commenced in late 2017, when the first of the new trial electric cargo vehicles began operation. These vehicles were fitted with identical Fleetcarma data trackers to record the data.

2 Low Carbon Vehicle Partnership: https://www.lowcvp.org.uk/

Data Collection

Data was collected from two main sources, the Gnewt Cargo telematics system operated by Fleetcarma and Gnewt Cargo's own 'Management Information' – referred to as MI hereafter.

Fleetcarma

Fleetcarma is a Canadian-based Information and Communications Technology company which utilises GPS tracking and on-board telematics to automatically log metrics including, but not limited to, energy usage and efficiency, distance travelled, driver behaviour and, greenhouse gas emissions.

Fleetcarma reports in real-time and static reports can be exported from the web interface covering a desired time-period. Fleetcarma data is automatically uploaded to the web interface meaning mistakes and missing data are rare.

One limitation, however, is that all data on the website is cumulative for the time scale selected. This resulted in a time intensive data extraction process as each weekly report had to be extracted individually; in total, 26 .csv extracts were exported.

For this trial **distance travelled** and **energy usage** were extracted for analysis.

The data from Fleetcarma was validated by the on-road, delivery cycle simulations completed by LowCVP in September 2019.

Gnewt Cargo MI recorded driver start, and finish times and the number of parcels delivered by each vehicle each day.

To compile a thorough and representative baseline, which accounted for anomalies, Fleetcarma data was collected from:

- January 2017 to September 2019 for the smaller EVs;
- August 2017 to September 2017 for the two rented diesel vehicles; and
- November 2017 to September 2019 for the trial EVs.

Data collected covered the cumulative totals by week, as above. This generated a thorough and complete set of data on Gnewt Cargo's current EV fleet which was comparable to the weekly data collected on the diesel vehicles.

By using data from January 2017 for the EVs, a more accurate representation of the data was achieved. However, due to the limited leasing period, only six weeks of data was available for baseline analysis of the diesel vehicles. The additional LowCVP baseline testing has been used to augment the original six-week study.

Challenges

The initial challenge was how to streamline large datasets into a fully comparable, tangible data source for future analysis? The problem was overcome via improved insight into the values, context and definitions of the raw data and clear definition of the required outputs.

Throughout the trial, other technical and logistical challenges arose:

- The hire vehicles did not commence activity until August 2017; later than initially planned.
- The keys to one of the diesel vehicles were lost, hence it could not be used for one week.
    - To address these issues the hire period was extended, ensuring that the required volume of data was acquired.
- Instances where Fleetcarma data was missing or incomplete - the arithmetic mean allowed for some data omissions and the reasons for the missing data were investigated by Gnewt Cargo with Fleetcarma.
    - It was later confirmed by Gnewt Cargo that GPS data from short journeys (i.e. a vehicle moving from one building to another in very close proximity) was not always captured as the tracker device had insufficient time to pick-up the satellite signal.
- As mentioned previously, there was some concern over the accuracy of Fleetcarma data for fuel use for the Fiat Ducato.
    - LowCVP's independent test of a Nissan NV200 fitted with a Fleetcarma device and a PEMS[3] determined that the average fuel economy and CO_2 emissions for the NV200 were 8 l/100km (288 MJ/100km) and 204 gCO_2/km, respectively.
    - Fuel use by the Fiat Ducato from the original baseline was 30% higher than the NV200 in the additional testing. Therefore, the Ducato fuel use and CO_2 emissions are taken as 10.4 l/100km (374 MJ/100km) and 265 gCO_2/km, respectively.
- The Nissan NV200 diesel van did not, in comparison to the other vehicles used, travel a long distance. The only metric affected by this is the average weekly distance covered. All other metrics used to assess the vehicles were unaffected by the lower travel distance.
- Whereas in the Baseline Data Report it was assumed that there was a standard parcel size. Due to the size of the larger trial EVs and the operational period of the trial, anecdotally it was noted that Gnewt were able to modify their operations and

[3] Portable Emissions Measurement System

deliver a wider variety of parcels sizes than during the period of baseline data collection and the time previous.[4]

[4] Parcel sizes (dimensions & weight) are not available from the data sources

Data Analysis

Analysis of the Fleetcarma data was split into three main categories;

1. Energy Usage
2. Time on the road
3. Delivery Performance

These metrics enable a comprehensive review of the vehicles' performance and the interaction of drivers with them.

Where anomalies were found in the Fleetcarma data during the monitoring period, the arithmetic mean was used to generate an 'average' representation of each vehicle type. The mean was used in all data analysis where vehicle types were grouped and was calculated using the raw data sets for improved accuracy.

Assumptions

Throughout the baseline data analysis, assumptions have been made to ensure continuity throughout the project.

It has been assumed that:

- Drivers drive at the same average speeds;
- Vehicles are maintained to run at the same standards, regardless of vehicle type; and
- Weekly distance is a suitable measure to compare time on the road.

Results

Energy Usage

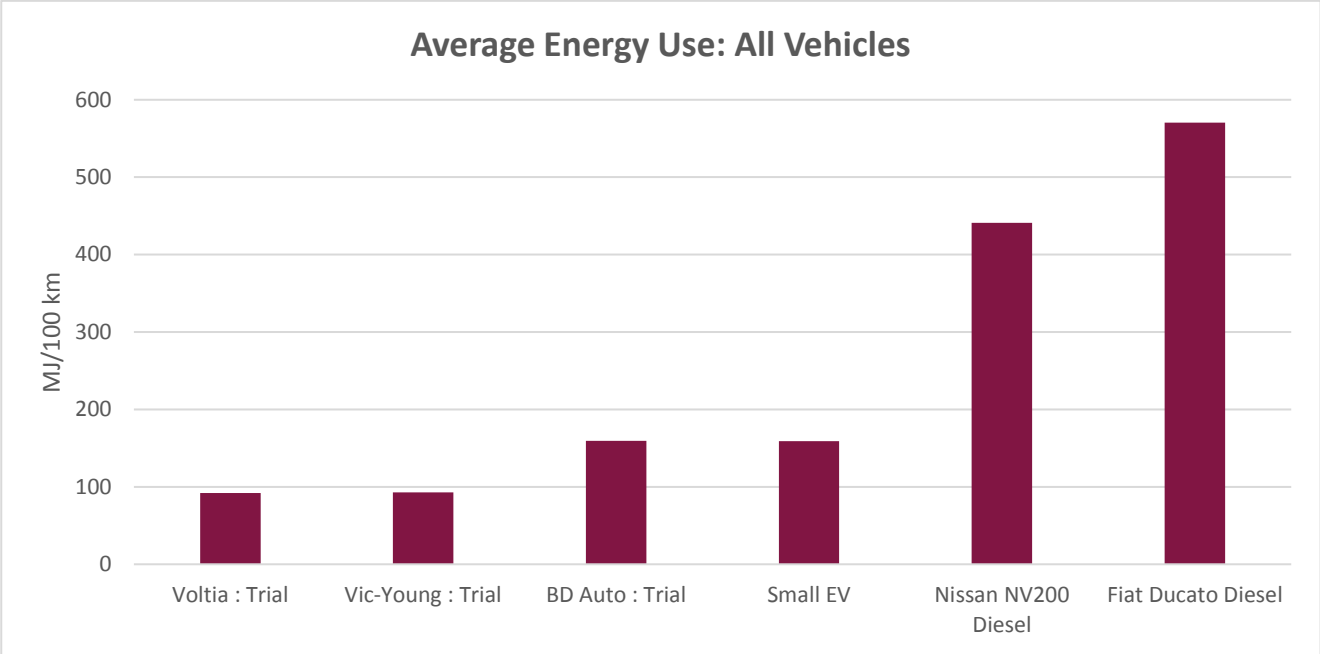
The fuel usage of each vehicle is recorded by Fleetcarma using a conversion to calculate how efficient both the electric and diesel vehicles are comparably (l/100 km.eq.); the fuel usage variable is based on this the energy usage of the two fuel types.

The figures were converted to Mega Joules per 100 km travelled (MJ/100 km) to more accurately compare energy usage between the two different fuel types; A conversion factor of 35.96 MJ/l was used for the conversion[5]. For comparison purposes, two calculations were conducted on the raw data received from Fleetcarma:

[5] Conversion factor calculated from:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820600/DUKES_A.1-A.3.xls

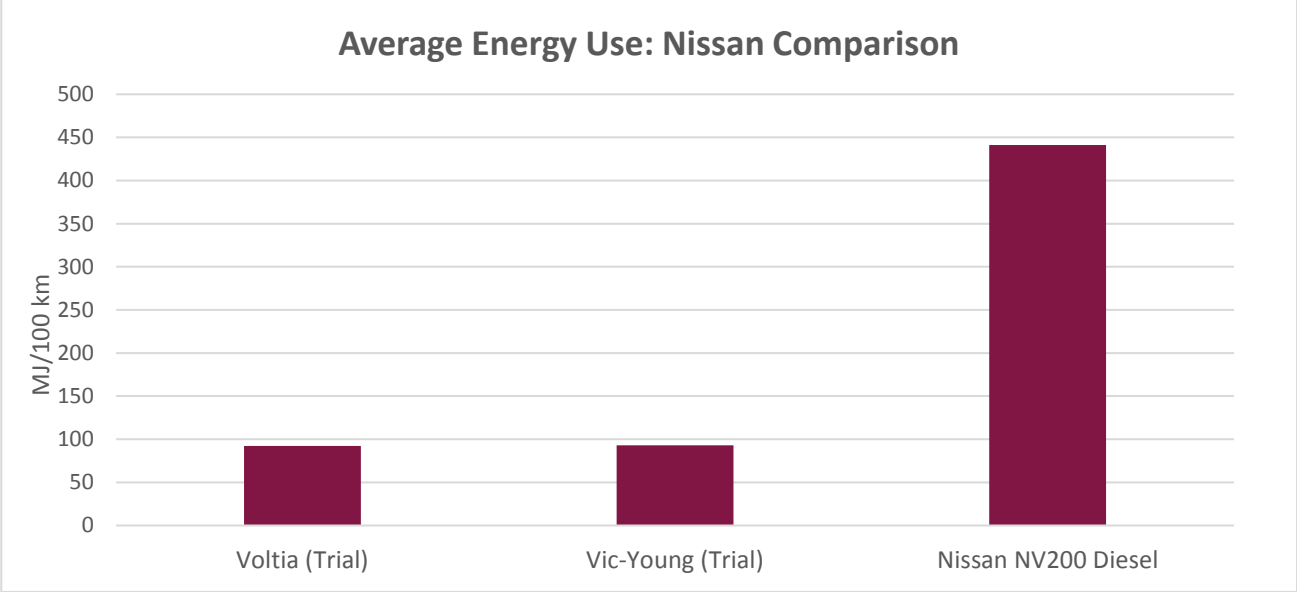
1) The average energy use over the entire duration of trial was calculated for each vehicle type.
2) The average energy use across different vehicles of the same type was calculated.

Figure 1: Comparison of all vehicles' energy usage.



Figures 1 presents the data gathered on all vans. The diesel vans are the most energy intensive; the Fiat Ducato diesel uses 570 MJ/100km, or 520% (a little more than five times) more energy than the trial EV Nissan Voltia (92 MJ/100km). To follow, more detailed comparisons are made between the most equivalent vehicles.

Figure 2: Comparison of Nissan-derived Trial vehicles to diesel.



Figures 2 shows a more specific comparison between the Nissan-derived vehicles. The figure shows that the Nissan NV200 uses 441 MJ/100km, an increase of 376% from the original value (almost five times more) energy than the Nissan trial vehicles (92-93 MJ/100km). In practice, this translates to the Nissan trial vehicles travelling the same distance as the diesel yet consuming five times less energy.

Figure 3: Comparison of BD Auto eDucato trial to Fiat Ducato Diesel.

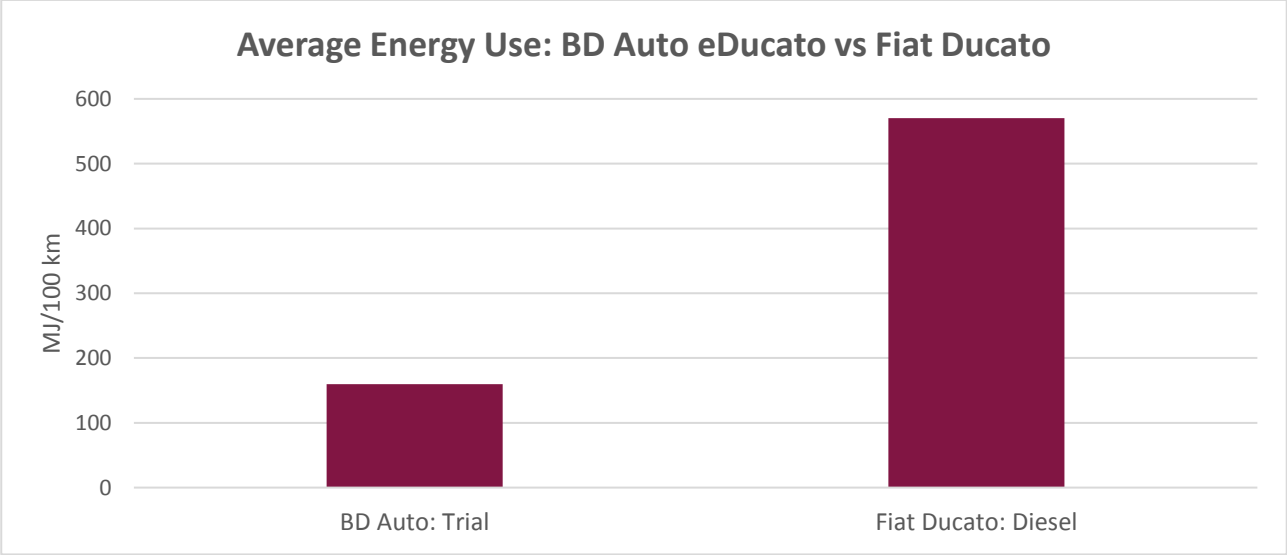


Figure 3 shows that the diesel Fiat Ducato uses 570 MJ/100km which is 256% more (just over 3.5 times more) than the BD Auto eDucato trial vehicle (160 MJ/100km).

Key findings:

- Diesel vans use more energy than electric vans to travel the same distance;
- Nissan NV200 diesel vans use five times more energy than Nissan trial EVs (Voltia and Vic Young);
- Fiat Ducato diesel vans use 3.5 times more energy than the BD Auto eDucato trial EV; and
- The Voltia and the Vic-Young vehicles consume less energy than the small EVs (shown in Figure 1). This is likely to be because the trial EVs are newer models with more efficient powertrains than the existing fleet.

Time on the Road

The time on the road has been analysed to understand the distances travelled during a last mile delivery operation such as that operated by Gnewt Cargo and understand the state of battery charge at the end of the delivery cycle in relation to general concerns regarding EV range.

To compare the time on the road, weekly distance was used as a measure. As with energy use, the average weekly distance travelled was calculated using Fleetcarma data for the duration of the trials. The average of all the different vehicles within a single type was calculated. In addition, the state of charge (SOC) on return to the depot was captured in conjunction with the distance travelled to understand how much battery charge remained at the end of a delivery day. This data was captured by Fleetcarma for the whole fleet rather than individual vehicles.

Two things must be noted with regards the weekly distance analysis; first, the diesel vehicles were only in operation for six weeks compared to the two-year long period that the EVs were in circulation. Second, the Nissan NV200 (diesel vehicle) did not travel as far as the trial EVs. However, that has no impact on the validity and significance of the data extracted from its operation.

As per Figure 4, the average distance travelled by all vehicles over the trial was 174 km per week (35 km per day). On average, the vehicles left the depot with 92% charge and arrived back at the depot with 62% charge remaining. This demonstrates that both the existing EV fleet and trial EVs, have more than adequate range to complete the sort of distances travelled during last mile delivery journeys. Whilst there is some variance in end state of charge (with a minimum of 52% seen in November 2019) the charge remaining following daily use remains relatively consistent over seasons and despite increased driving distances.

Figure 4: Weekly travel distance and state of charge

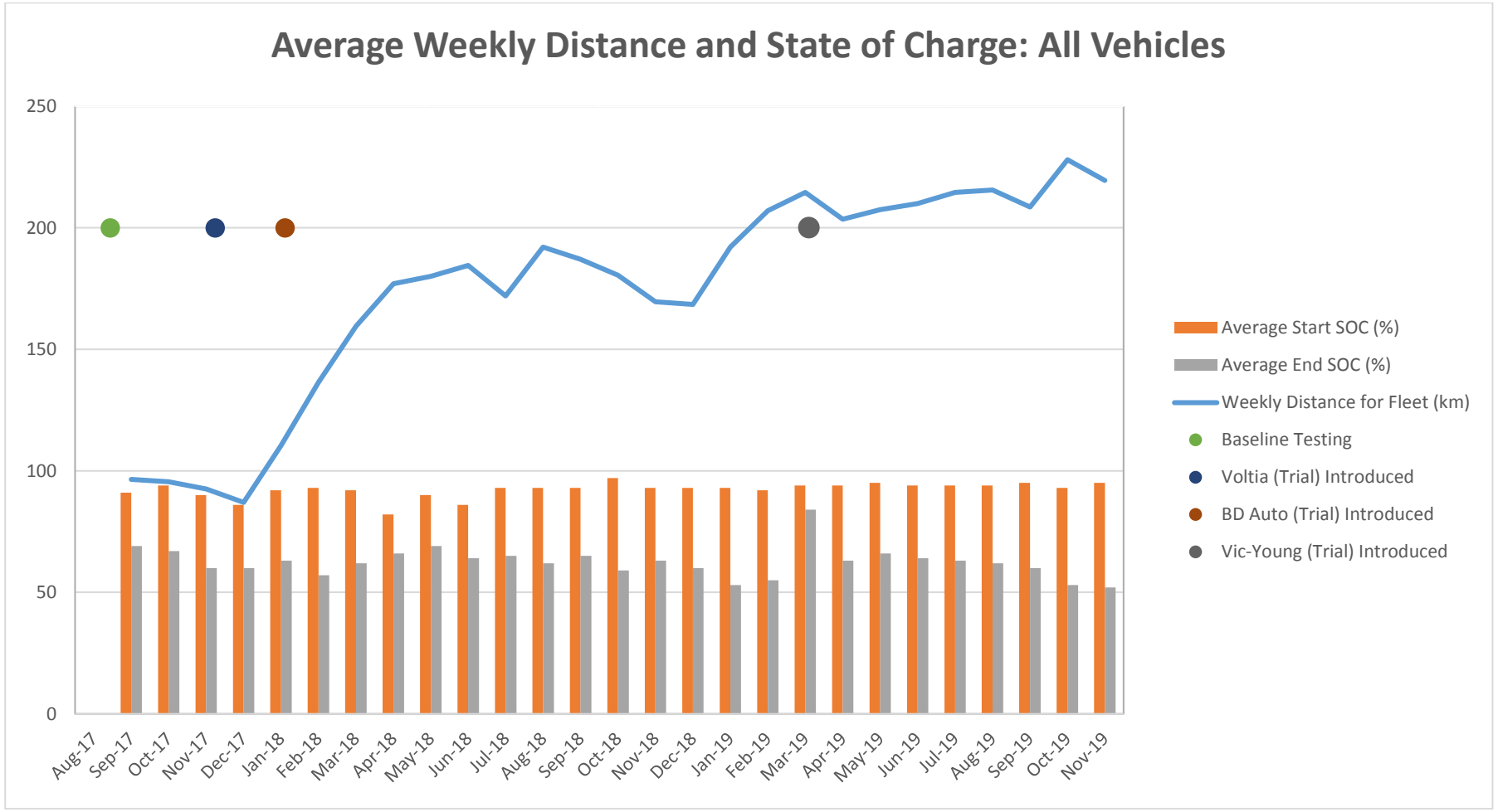


Figure 5: Comparison between trial EVs and small EVs

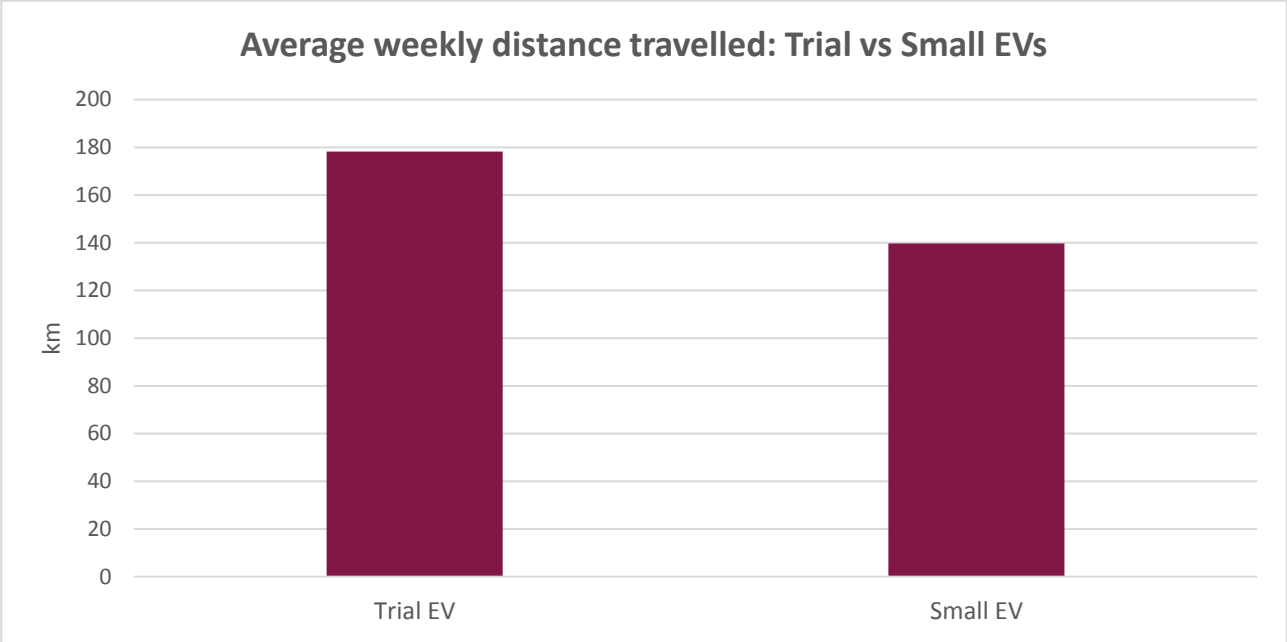


Figure 5 confirms the trial EVs travel 178 km per week on average, 20% farther than the small (Renault Kangoo) EVs at 140 km per week.

Key findings

- Trial EVs travelled 20% more distance than the small EVs;
- Between all trial EVs, the Voltia travelled the longest distance;
- On average, one days' worth of last mile deliveries used approximately 30% of the battery's charge; and
- Distance travelled is a good approximation of time spent out of depot.

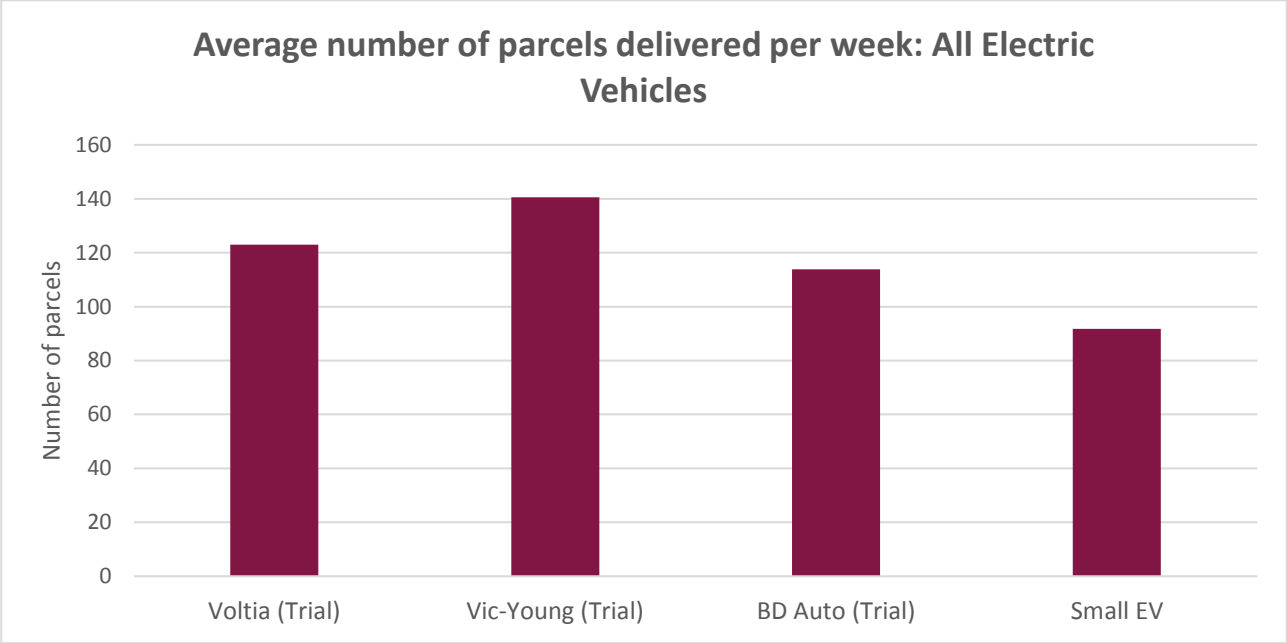
Delivery Performance

The number of parcels delivered was used to measure the operational performance of each vehicle. For comparison purposes, the average of all the collected parcels over the trial period was calculated per vehicle. The average of each vehicle type was calculated as was done with energy use and time on the road.

It must be reiterated that Gnewt operations were altered as a result of the trial, meaning that larger parcels were delivered by the trial EVs than the standard parcel sized assumed during the baseline data collection period (see Baseline Data Report). This operational change has

improved the flexibility of Gnewt operation and the type of client Gnewt can make deliveries on behalf of.

Figure 6: Average parcel delivery per week for all the vehicles.



The trial EVs all showed an improvement on the delivery capacity (average 125 parcels per week) compared to the small EVs at 92 parcels per week.

Compared to the small EVs, the Vic-Young showed a 53% increase in parcel deliveries and the Voltia a 34% percentage increase. Conversely, the BD Auto eDucato, saw only a 23% increase in number of parcels delivered compared to the small EVs. However as mentioned previously, the disparity between size increase and parcel delivery can be explained by the BD Auto eDucato enabling the delivery of larger parcel sizes.

The main limiting factor in delivery capacity remains ‘how many parcels a driver can physically deliver’ in a working day. Some of this is dependent on the nature of the parcel to be delivered and proximity of delivery locations to each other and to the depot.

Key findings:

- Trial EVs delivered more parcels per week on average than the small EVs
- The Vic-Young had the highest average number of deliveries out of the trial EVs, followed by the Voltia and the BD Auto eDucato;

Conclusion

Below are succinct vehicle data analysis summaries for each trial EV.

The trial Nissan Voltia and Nissan Vic-Young used significantly less energy than the diesels and small EVs and compared favourably with the small EVs in terms of distance travelled and productivity.

The BD Auto eDucato used less energy than the diesel van and travelled further and delivered more parcels than the smaller EVs, but its energy use was similar to that of the small EVs.

The data analysis tells an important part of the story when assessing performance of the trial vehicles, but not the whole story. What the vehicles were like to drive and operate will be covered in the Final Report.

Nissan Voltia (Trial EV)

Energy

- Uses almost five times less energy than the diesel vans; and
- 35% less energy than small EVs.

Distance Covered

- 34% more distance covered than the small EVs; and
- Was not compared to Nissan NV200 (see Challenges section).

Productivity

- 34% more parcel deliveries per week on average than the small EVs.

Improvement on the small EVs across all three metrics.

Improvement on the diesel NV200 in terms of energy use.

Nissan Vic Young (Trial EV)

Energy

- Uses almost four times less energy than the diesel vans; and
- 35% less energy than small EVs.

Distance Covered

- 15% more distance covered than the small EVs; and
- Was not compared to Nissan NV200 (see Challenges section).

Productivity

- 53% more parcel deliveries per week on average than the small EVs;

Improvement on the small EVs across the three metrics.

Improvement on the diesel NV200 in terms of energy use.

BD Auto eDucato (Trial EV)

Energy

- Uses 3.5 times less energy than the diesel vans; and
- No considerable difference in energy use when compared to the small EVs.

Distance Covered

- 14% more distance covered than the small EVs; and
- 40% less distance covered in comparison to the Fiat Ducato.

Productivity

- 23% more parcel deliveries per week on average than the small EVs.

Improvement on the small EVs in terms of distance covered and productivity but similar in terms of energy use.

Improvement on the Fiat Ducato in terms of energy use.

Other formats and languages
For a large print, Braille, disc, sign language video or audio-tape version of this document, please contact us at the address below:

Public Liaison Unit
Greater London Authority
City Hall
The Queen's Walk
More London
London SE1 2AA

Telephone **020 7983 4100**
www.london.gov.uk

You will need to supply your name, your postal address and state the format and title of the publication you require.

If you would like a summary of this document in your language, please phone the number or contact us at the address above.