MAYOR OF LONDON

Mayor of London / Gnewt Cargo Electric Vehicle Trial

Final Report

February 2020

Innovate UK

gnewt BY MENZIES DISTRIBUTION

Data Analysis Partner:

ARUP

COPYRIGHT

Greater London Authority
March 2018

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

CONTENTS

Executive Summary 1

Introduction 6

- **Background** 7

Results 10

- **Project Data Analysis** 11
- **Cost Analysis Summary** 12
- **Emissions Assessment Summary** 13

Review of the Trial Vehicles 15

Lessons Learned During the Gnewt Cargo Trial 20

- **Operation in Urban Environments** 21
- **Technology** 22

The Future of Electric Vans 23

- **Infrastructure needed to support future potential** 24
- **The impact of large-scale electric van adoption on London UK Power providers and potential mitigation strategies** 25
- **Business cost implications: Leasing vs purchasing financial case** 28
- **Availability** 30

Conclusions 32

Executive Summary

The Mayor of London / Gnewt Cargo Project (which ran from July 2017 to December 2019) examined the performance of modified, larger[1] electric vehicles (EVs) used for delivery and logistics purposes in London.

The project is divided up 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**

The final report summarises insights from previous reports and is not intended to cover all aspects of the trial in depth. It is recommended, therefore that it be read in conjunction with the other reports listed above.

This report consolidates the trial's key findings, drawing insights from the previously published reports, plus full vehicle evaluations.

The four main areas of focus are:

- Operational performance
- EV operating costs in practice
- Charging Infrastructure and Grid Analysis
- Key barriers to the adoption of EVs

Data from three trial electric light goods vehicle (LGV) models was gathered over a two-year period and analysed against data compiled from a baseline trial operated with comparator

[1] 7.5-13m^3 capacity

diesel and the smaller electric LGVs that comprised Gnewt Cargo's original electric fleet (see Appendix A - Gnewt Cargo vehicle matrix).

Analysis of the data collected revealed some key messages:

Operational Performance
On average, the **trial EVs (7.5 - 13m³) travelled 27% further** and were out of the depot for longer amounts of time each day than their smaller EV counterparts (3.4 - 4.2m³).

Operationally, the trial EVs, with their larger payload volumes (the amount of things a vehicle can carry), **delivered on average 30% more parcels per week** than the smaller EV fleet.

Driver experience
An important part of the vehicle evaluation is the driver experience, the human factors feedback should go hand-in-hand with performance data when considering a new fleet vehicle.
Through driver surveys which assessed a range of factors, each vehicle produced an overall satisfaction score.

Drivers rated the overall satisfaction for the Voltia as a **4.2/5**
Drivers rated the overall satisfaction for the Vic Young as a **3.5/5**
Drivers rated the overall satisfaction for the BD Auto eDucato as **4.4/5**

See Review of the Trial Vehicles section in this report for full details.

EV operating costs in practise
The overall **fuel[2] costs for the trial electric LGVs are 75% less than diesel LGVs**, based on 2019 projections and there are significant socio-environmental benefits associated with electric LGVs replacing diesel equivalents.

These equate to an **estimated 1.8p to 2.6p benefit, per kilometre driven, to Greater London**. This benefit is predominantly linked to a reduction in greenhouse gas emissions (see Results section of this report under Cost Analysis).

Whilst the analysis of total operating costs for the trial EVs shows them to be on average 1% more expensive to operate than their diesel equivalents, this is as a direct result of the unique trial conditions (i.e. short lease period).

---

[2] Electricity costs to charge for EVs

The smaller electric LGVs, such as the eNV200 and Renault Kangoo EV were about **20% less expensive to operate than their diesel equivalents**.

Energy Usage
Overall, the trial Voltia and Vic-Young EVs used significantly less energy per km than the diesels and small EVs and compared favourably with the small EVs in terms of distance travelled and productivity.

- Nissan NV200 diesel vans use five times more energy than Nissan trial EVs (Voltia and Vic Young)
- The Voltia and the Vic-Young vehicles consume less energy than the small EVs. This is likely to be because the trial EVs are newer models with more efficient powertrains than the existing fleet

Charging Infrastructure and Grid Analysis
The charging and grid analysis showed that smart charging has **reduced the grid connection size** needed to accommodate the larger Gnewt Cargo fleet **by over 100%,** and the use of smart charging reduces the grid and operational charges associated with the larger EV fleet.

Smart charging can reduce the peak load and avoids the need for costly and lengthy grid upgrades (130% increase in capacity would have been required on this trial without smart charging), including the potential installation of another transformer near the EV depot.

Air Quality – impact on emissions
To demonstrate the pollutant savings from the use of the trial EVs as a replacement for equivalent diesel LGVs, an assessment was undertaken to calculate the tailpipe emissions which would have been generated by diesel LGVs.

- Total savings for the completed trial (trial EVs only) are as follows:
  - PM10 – 1,136.8 g
  - NOx – 481.3 kg
  - CO2 – 77.9 t

These figures cover the period November 2017 to September 2019. They were derived from 26 trial vehicles completing final-mile deliveries which gives an indication of the potential impacts of large-scale adoption of EVs across London and the UK.

Key barriers to the adoption of EVs
We identified two critical barriers to the widespread adoption of electric LGVs within London. One barrier is poor availability of the vehicles. Relative to diesel powered vans, the range of EV models and size options available on the UK market is very restricted due

to low production and market allocation to other countries offering attractive incentives (See *Key Barriers Report* for more details).

The other barrier is cost. When purchased from new, EVs are (currently) more expensive than their diesel counterparts. This disparity in cost is changing and it is hoped that an equilibrium will be reached in the near future. For this to be achieved new manufacturers need to enter the market, battery costs must decrease, and the UK needs to secure a greater share of the available vehicles (Government policy and incentives can aid this objective).

Other barriers include inadequate charging infrastructure, energy cost, legislation/policy and range anxiety (i.e. will the battery run out of charge before a journey is completed).

- Charging infrastructure – Stakeholders felt there are too few public on-street charge points accessible to vans (including in residential areas as many self-employed drivers will take vans home)
- Energy cost – Stakeholders reported that some freight operators are fearful that electricity costs will increase significantly in the future. This is not supported by Government predictions with the cost of electricity predicted to change very little over the next 18 years.
- Legislation/Policy – There is some inability to access charge points between network providers (interoperability issues) and calls have been made for UK Government to intervene. There are also calls for a Code of Practice for vehicle charging and energy use.
- Range anxiety - There remains a perception of limited EV range which can be a barrier to adoption, especially to small freight companies and self-employed drivers. Range anxiety is linked to a driver's concerns over the stem mileage (distance from origin to area of delivery and from end of delivery back to end destination) and ability to complete the required deliveries without needing downtime to recharge. One solution to range anxiety for urban use is to publish more data about true operations, such as the one featured in this trial, to dispel these concerns.

All of these barriers and potential solutions are covered in the *Key Barriers Report.*

Introduction

Background

The Mayor of London / Gnewt Cargo project (which ran from July 2017 to December 2019) examined the performance of a set of innovative electric vehicles (EVs) used for delivery and logistics purposes in London. The project assessed trial vehicles against a range of logistical, environmental and economic performance factors. Trial EV performance was compared to baseline data from equivalent diesel vehicles and

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 $8.5m^3$/ payload 1,035 kg). This project sought to examine the benefits/disbenefits of the introduction of larger EVs to London roadways. The different phases of the trial are shown in Figure 1.

Our Approach

The first phase of the project, which ran from July to September 2017, established a baseline to enable early stage comparisons using a range of environmental, economic and other key performance indicators. Relevant backdated data (from January 2017) was gathered from Gnewt Cargo's existing EVs which were fitted with the Fleetcarma fleet telematics system. Fleetcarma uses GPS tracking and on-board telematics to gather and log metrics such as:

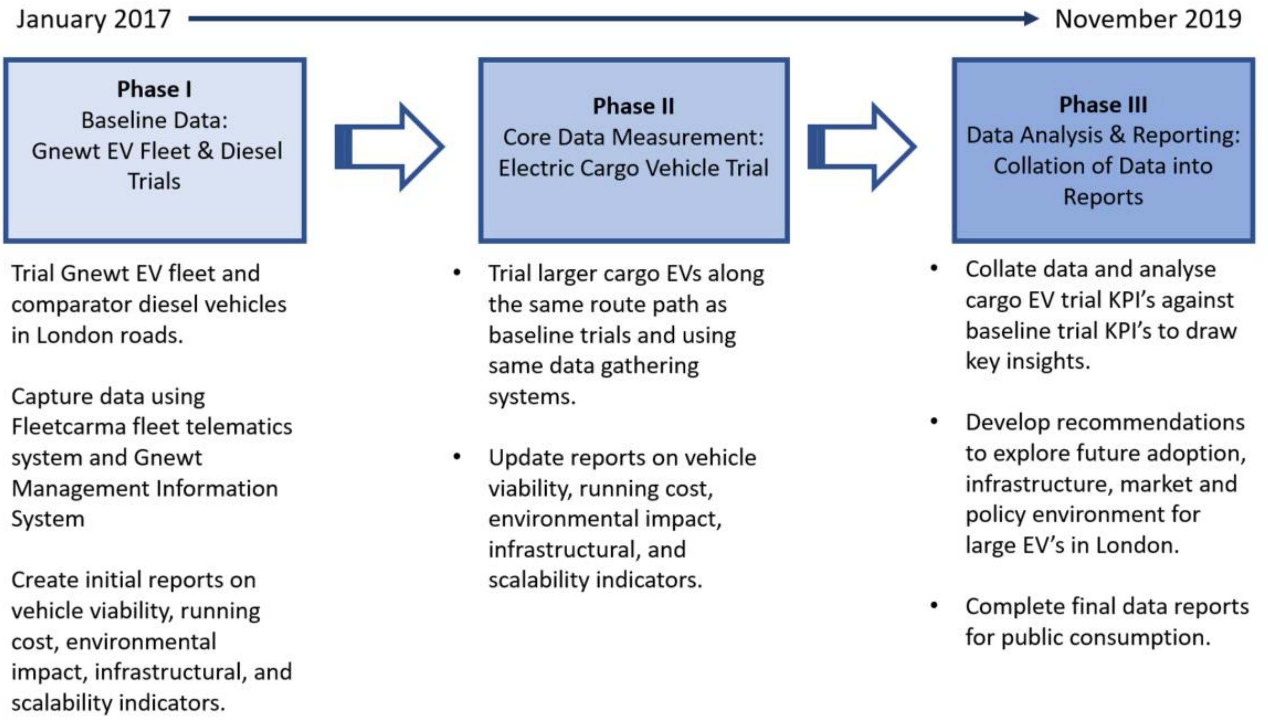
- Fuel usage and efficiency
- Distance travelled
- Driver behaviour
- Greenhouse gas emissions

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[3] 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.

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

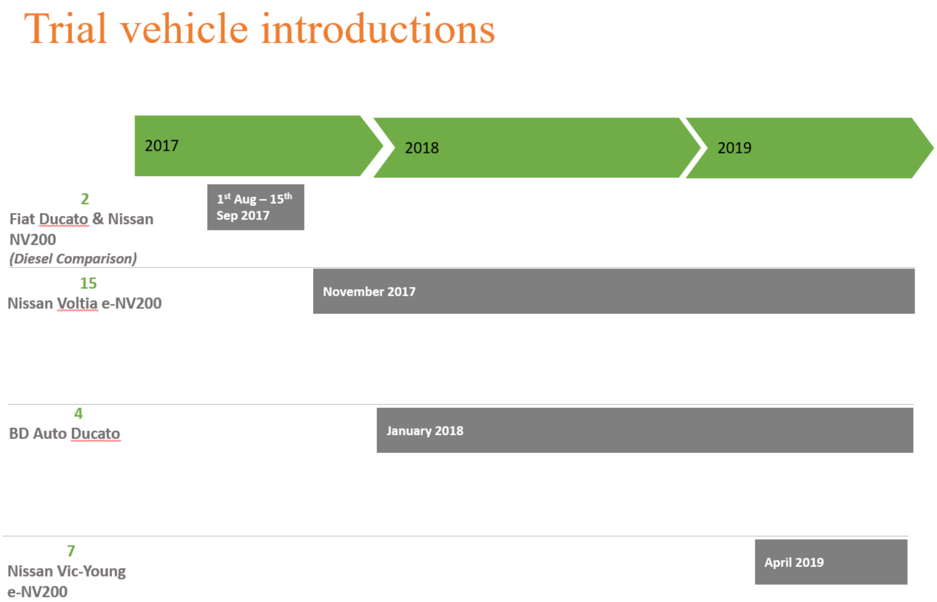
Figure 1: Diagram of the various project stages that constitute the Mayor of London/ Gnewt Cargo Electric Vehicle Trial Project



Trial vehicle onboarding

The 26 trial vehicles were introduced in stages throughout the trial period as shown in figure 2 below.

Figure 2: Trial vehicle introductions



Report Structure

The objective of this report is to offer a comprehensive analysis of the benefits and dis-benefits of adopting larger[4] EVs in London. Full versions of each of the reports detailed in the Executive Summary section can be found on the Data Store[5]. This report is structured as follows:

The section "**Results**" presents the key findings of the trial for each vehicle type, referring to the *Final Data Analysis Report* and the *Baseline Data Analysis Report*. This section also summarises Cost Analysis findings and key Emissions Assessment results.

The section "**Review of the Trial Vehicles**" presents a review of each style of trial vehicle including information about cargo capacity, vehicle costs, and insights from driver surveys. The section is a guide for readers intended to describe vehicle performance and to help them assess which, if any, model might suit their requirements.

The section "**Lessons Learned During the Gnewt Cargo Trial"** discusses the challenges and complexities relating to operation of both the larger trial EVs and the original Gnewt Cargo fleet. The section lists lessons that, whilst specific to this trial, may be helpful to those with an unresolved EV fleet operations issue or who are considering a move to EVs.

The section "**The Future of Larger Electric Vans**" discusses the future of larger EVs in terms of infrastructure requirements for London and some key barriers to widespread adoption. The assessment includes consideration of the impact of larger EVs and the use of smart charging infrastructure on the power network, as well as an overview of the leasing versus purchasing financial case.

---

[4] 7.5 – 13m^3 capacity

[5] https://data.london.gov.uk/dataset/low-emissions-project-diesel-vehicle-baseline

Results

Project Data Analysis

This section outlines key insights gathered from the final data collected from the Fleetcarma telematics system over the trial period. To gather this data, Gnewt Cargo trialled;

- Nissan Voltia eNV200s (hereafter referred to as 'Voltia')
- Vic-Young modified eNV200s (hereafter referred to as Vic-Young) and
- BD Auto eDucato's.

The performance of these trial vehicles was evaluated against Gnewt Cargo's existing fleet of smaller EVs. The existing all-electric fleet comprised Nissan eNV200s and Renault Kangoo.

In 2017, two diesel vehicles, a Nissan NV200 and a Fiat Ducato, were hired and operated to provide further baseline data for comparison. Analysis of the data was split into three main categories:

- Energy Usage
- Time on the Road
- Delivery Performance

These metrics enable a comprehensive review of the vehicles' performance and the interaction of drivers with them. The findings showed that the trialled EVs consumed less energy than their diesel counterparts, covered greater distances than smaller EVs and delivered more parcels than the smaller EVs.

To follow is a summary of the key findings of this data analysis. For full, detailed reports on the data methodology and findings please refer to the *Baseline Data Report* and *Final Data Analysis Report*.

Energy Usage

- 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
- The Voltia and the Vic-Young vehicles consume less energy than the small EVs. This is likely to be because the trial EVs are newer models with more efficient powertrains than the existing fleet

Time on the Road

- Trial EVs travelled 20% further on average per week than the small non-trial EVs
- Of all trial EVs, the Voltia travelled the greatest distance
- On average, one day of last mile deliveries used approximately 30% of the battery's charge

Delivery Performance

- Trial EVs delivered 35% more parcels per week on average than the small EVs
- The Vic-Young showed a 53% increase in parcel deliveries per week on average, the Voltia 34% and the BD Auto eDucato 23%[6]

Parcels sizes were not available for the trial although anecdotally the increased payload of the trial EVs meant they were often used for larger parcels.

Overall, the trial Voltia and Vic-Young EVs used significantly less energy per km 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 per km than the diesel equivalent van and travelled further and delivered more parcels per week than the smaller EVs, but its energy use per km was similar to that of the small EVs.

Cost Analysis Summary

The Gnewt Cargo EV trial provided an insight into the practical performance and economic feasibility of a move to cleaner and more efficient freight traffic in London. Given the Government's plan to cease the sale of conventionally powered vehicles by 2035 and eliminate fossil fuel vehicles from UK roads altogether by 2050, the findings derived from this trial help quantify the implications for LGVs in London over the next decade as the adoption of EVs increases.[7]

[6] The reason for the variation is explained in the Final Data Analysis Report

[7] In February 2020 the UK Government announced plans to bring the date forward to 2035 from 2040.

Our headline finding is that overall fuel[8] costs for electric LGVs are 75% less than diesel LGVs, based on 2019 projections.

There are significant socio-environmental benefits associated with electric LGVs replacing diesel equivalents. These equate to an estimated 1.8p to 2.6p benefit, per kilometre driven, to Greater London[9]. This benefit is predominantly linked to a reduction in greenhouse gas emissions.

These benefits do not directly translate into cash value; rather, they reflect the value Government places on a reduction of GHG emissions, noise and local air pollution. These values are driven by an expectation of the avoided healthcare and climate change mitigation costs associated with these emissions.

The proportion of small and large EVs in the electric fleet influences how expensive it will be to operate when compared to a fully diesel fleet. Smaller EVs such as the eNV200 and Renault Kangoo, for example, were about 20% less expensive to operate than their diesel equivalents.

The larger trial EVs were on average 1% more expensive to operate than the diesel equivalents due mainly to higher lease costs linked to the relatively short duration of the trial. A fleet operator considering switching from diesel to EV may be able to negotiate a better value, longer lease period, thereby reducing costs.

The analysis results are based entirely on the driving patterns and operations of the Gnewt Cargo trial fleet. The estimated socio-environmental benefits may change given variations in how LGVs are operated, the necessary range required, and the payload carried.

Emissions Assessment Summary

To demonstrate the pollutant savings from the use of the trial EVs as a replacement for equivalent diesel LGVs, an assessment was undertaken to calculate the tailpipe emissions which would have been generated by diesel LGVs.

This assessment was based on the distance travelled and equivalent amount of diesel fuel used by the EVs during November 2017 to September 2019.

---

[8] Electricity costs to charge for EV's

[9] Reflects the associated costs provided by DfT guidance for vehicle noise, air pollution and carbon emissions. DfT TAG Data Book (2017).

The assessment considered vehicle exhaust emissions of oxides of nitrogen (NO_x), particulate matter (PM_{10}) and carbon dioxide (CO_2). With zero exhaust emissions from EVs significant emissions savings are possible as shown in Tables 1 & 2 below
The total savings during the trial period of November 2017 to September 2019 are presented in Table 1.

Table 1: Savings during the trial period by vehicle type (trial vehicles highlighted rows in blue)

Vehicle type	**Total savings for trial period (PM g)**	**Total savings for trial period (NO_x kg)**	**Total savings for trial period (CO_2 t)**
Voltia (trial)	844.2	357.5	57.0
Nissan eNV200	175.3	74.2	10.7
Renault Kangoo	1,391.0	589.0	85.1
BD Auto eDucato (trial)	161.4	68.3	12.8
Vic-Young (trial)	131.1	55.5	8.0
Total	**2,703.0**	**1,144.5**	**173.6**

Total emissions savings for the completed trial (trial EVs only) are as follows:

Table 2: Savings during the trial period - trial vehicles only

Emission type	**Total savings for trial period (November 2017 to September 2019)**
PM_{10} g	1,136.8
NO_x kg	481.3
CO_2 t	77.9

Review of the Trial Vehicles

This section presents a review of each variant of trial vehicle including:

- Performance analysis
- Capacity analysis
- Costs analysis
- Driver survey analysis.

Using the data discussed in the Results section of this report and responses gathered from driver surveys, these reviews provide an objective breakdown of the trial EVs for the consideration of businesses seeking to incorporate cargo EVs into their operations.

The reviews are designed to provide a guide for readers to assess which, if any, of the models trialled might best suit their requirements. Below are succinct vehicle summaries for each trial EV variant:

The Voltia (modified Nissan eNV200) is ideal for those seeking to add a compact, comfortable, electric cargo vehicle to their fleet. The Voltia has an energy use of 92 MJ/100km. It is ideal for urban environments which require less range for delivery operations and contain smaller parking spaces.

The Vic-Young (modified Nissan eNV200) is ideal for those seeking a mid-sized, easy-to-handle, electric cargo vehicle to their fleet. The Vic-Young has an energy use of 93 MJ/100km. Planning delivery routes around charge points may be required therefore the vehicle may be better suited to urban environments which require less range for delivery operations.

The BD Auto eDucato is ideal for those seeking an energy efficient, reliable vehicle with a large payload capacity. With an energy use of 160 MJ/100km the BD Auto eDucato is more than 3.5 times more efficient than the diesel version and its payload is just less than twice that of the Voltia.

These vehicles are reviewed in greater detail on the following pages.

Nissan Voltia eNV200 (Voltia)
Purchase Price: £16,185 (+VAT @20% £3,237 + Voltia expansion) Total = £27,000-£30,000

Lease Cost: £500 / month

The Voltia is a quiet, comfortable, low emission cargo van with mid-sized cargo space and excellent mileage. Ideal for operations city/urban environments.

Vehicle Performance

Modified in Slovakia, the Nissan Voltia eNV200 is larger than the traditional eNV200, offering a payload volume of 7.5 m^3. The vehicle weighs approximately 2,000 kg and has an average energy use of 92 MJ/100km. Its battery holds 22 kWh on a full charge and energy costs are about £0.86 per km. On average, drivers of the Voltia eNV200 drove 39 km a day and required a daily charge of 10 kWh. The vehicle achieves full charge over a 12-hour period. The Voltia uses five times less energy than equivalent-sized diesel vans and travelled about 34% further per week than smaller EVs.

Technical Specifications	
Vehicle Class & Make, Model	N1, Nissan, e-NV200
Energy use (MJ/100km)	92
Dimensions -LxWxH (mm)	5030/1760/2420
Payload volume (m^3)	7.5
Gross weight (kg)	2,000 kg
Battery type	Lithium ion
Battery capacity (kWh)	22
Charging time (hrs)	50 min/wall;7.5 h/domestic:21 h
Emissions std.	Euro 6

Driver Feedback and Survey Insights:

Drivers rated overall satisfaction for the Voltia as a **4.2/5**:

- On average drivers rated performance, cargo capacity, noise and loading/unloading as 4.5/5;
- Safety was rated at 4.3/5;
- Vehicle reliability, comfort, maintenance, refuelling/charging, and parking were given an average rating of 4/5; and
- Vehicle range, ride and handling for the Voltia were given a 3.8/5 by drivers.

The main benefits noted by drivers were that the eNV200 was quiet, fast, comfortable and environmentally friendly. Key drawbacks mentioned were long vehicle charging times and limited range.

Vic-Young modified Nissan eNV200 (Vic-Young)
Purchase Price: £16,185 (+VAT @ 20% £3,237 + Vic-Young expansion) Total = £25,000-£30,000

Lease Cost: £500 / month

The Vic-Young is a fuel efficient, comfortable cargo van with mid-sized cargo space and excellent mileage. Ideal for operations city/urban environments.

Vehicle Performance

The Vic-Young modified Nissan eNV200 is manufactured in England and has been expanded to offer a larger payload volume of 8 m^3, compared to the smaller eNV200 and the diesel NV200 (both vehicles have a capacity of 4.2 m^3). This vehicle has an energy use of 93 MJ/100km travelled and has a battery capacity of 40 kWh on a full charge. Energy costs are about £1.05 per km. On average, drivers of the Vic-Young drove 37 km a day and required a daily charge of 10 kWh. The vehicle was fully charged over a 12-hour period. The Vic-Young uses four times less energy than its diesel counterpart.

Technical Specifications	
Vehicle Class & Make, Model	N1, Nissan, e-NV200
Energy use (MJ/100km)	93
Dimensions -LxWxH (mm)	5195/1800/2400
Payload volume (m^3)	8
Gross weight (kg)	2,220 kg
Battery type	Lithium ion
Battery capacity (kWh)	40
Charging time (hrs)	50 min/wall;7.5 h/domestic:21 h
Emissions std.	Euro 6

Driver Feedback and Survey Insights:

Drivers rated overall satisfaction for the Vic Young as a **3.5/5**:

- On average, performance, reliability, maintenance, comfort, parking, and noise were rated at a 3.5/5;
- Range, comfort, safety, ride & handling and refuelling/charging for the Vic Young model were given an average rating of 3/5; and
- Cargo Capacity and loading/unloading had the highest scores, with rating of 4/5 and 4.5/5 respectively.

The main benefits noted by drivers of the Vic-Young modified eNV200 were that it is easy to drive and environmentally friendly. Key drawbacks mentioned were difficulty parking due to the larger size of the vehicle, and the lack of noise from the vehicle making it more difficult for pedestrians to notice the van.

BD Auto eDucato
Price: undisclosed

Lease Cost: £3,250 / month

The BD Auto eDucato is a large and reliable low-emission cargo van ideal for operators looking for good mileage and a larger delivery capacity.

Vehicle Performance

The BD Auto eDucato is manufactured in Turkey and was the largest EV driven during the Gnewt Cargo trial. The vehicle has a payload capacity of 13 m^3. The BD Auto eDucato has an energy use of 160 MJ/100km driven and a battery capacity of 62 kWh. On average trial drivers of the BD Auto eDucato drove 35 km a day and required 10 kWh of charge daily. The vehicle was charged over a 12 period. The BD Auto eDucato uses 3.5 times less energy than the equivalent diesel van.

Technical Specifications	
Vehicle Class & Make, Model	N1, BD Auto, eDucato
Energy use (MJ/100km)	160
Dimensions -LxWxH (mm)	6366/2050/2522
Payload volume (m^3)	13
Gross weight (kg)	3,500 kg
Battery type	Lithium ion
Battery capacity (kWh)	62
Range on full charge (approx. in km)	258
Charging time (hrs)	7 h/single phase: 8-16 h
Emissions std.	Asynchronous water cooling

Driver Feedback and Survey Insights:

The average overall satisfaction score for the BD Auto eDucato was rated as **4.4/5** by trial drivers:

- On average, reliability, range, comfort, cargo capacity, refuelling/charging and noise had scores of 5/5;
- Maintenance and parking were rated at 4/5 by vehicle drivers; and
- The BD e-Ducato's performance and ride/handling had average scores of 3/5.

Drivers of the BD eDucato cited the vehicles large loading capacity and range as key benefits. Drawbacks mentioned during the survey include lack of a sat nav and slow vehicle ignition start.

Lease costs for this trial vehicle were affected by the short lease period of just 18 months.

Lessons Learned During the Gnewt Cargo Trial

Throughout the trial, lessons have been learned about the complexities of operating both the larger trial EVs and the original Gnewt Cargo fleet. The lessons listed in this section are specific to this trial but may also help those with unresolved problems in their EV fleet operations, or, who are considering a move to EVs.

Operation in Urban Environments

Routing

It was found, anecdotally, during both the baseline testing and following the introduction of the BD Auto eDucato vans, that due to their greater size the larger vehicles could not access and deliver to the same locations as the Renault Kangoo's and Nissan Voltia eNV200s.

Some routes were more difficult to access where deliveries were not made to a purpose-built service yard or on a main road due to narrow streets and unconventional London road layouts. The smaller non-trial Renault Kangoo and Nissan Voltia eNV200 were more versatile and capable of delivering to these locations. Furthermore, parking the larger BD Auto eDucato vans proved more difficult in the congested city environment.

Porter Model

One of the key lessons from the trial was a better appreciation of how the inner city, last mile delivery service could evolve to reduce the number of delivery vans on the road following observations of the distances travelled by vehicles.

A traditional delivery model sees couriers travel long distances over the working day. Historically, Gnewt Cargo vehicles travelled on average five miles per day on the delivery route (excluding stem mileage[10]), with delivery drivers still walking six miles on foot – a greater distance than that driven. EVs remain well suited to inner city travel due to the lower mileages driven, hence lessened range anxiety. However, the size of the Renault Kangoo used prior to this trial limited the number of parcels which could be loaded per vehicle and thus opportunities to make large numbers of deliveries on foot from the EV

The introduction of the larger Nissan Voltia eNV200 and BD eDucato vans allowed an eight-week trial of a 'Porter model' where one donor van was loaded with parcels and driven to a central location. It was parked, and parcels were collected by several Porters who delivered parcels on foot.

[10] The distance to and from a delivery zone

On average, 91% of parcels were delivered on foot against a target of 80%. It was found that one large capacity donor van, accompanied by four or five Porters, could replace up to five vans operating to the normal Gnewt model.

If the model were to scale up in the future, the increased volume would be supported by either multiple trips with one donor vehicle, a second donor vehicle or a larger van such as the BD Auto eDucato. This could reduce the number of delivery vehicles required to service the same destinations by up to 50%.

Technology

Few of the technologies utilised during the trial were new. However, the integration of existing systems to allow for 'smarter' charging and tracking represented a novel approach. Multiple obstacles were encountered. For example, the Fleetcarma GPS trackers in the vehicle fleet could not initially provide the charging infrastructure with the information required to identify which vehicle was charging at an individual charge post.

The key to solving the challenge was cross-software integration. One outcome to enable the solution was to replace the model C5 trackers with new versions (C2) which created fleet continuity and mitigated another potential issue with different versions of hardware. This involved charging immediately at low rate to trigger an event in the tracker. However, a series of additional obstacles were encountered which prevented the easy integration of the systems. For example:

- When a vehicle was plugged in to a charging point when already at 100% battery charge, the EO charging system hardware recognised that a vehicle was plugged in, but the Fleetcarma tracker installed in the vehicle did not send the required state of charge or timing information as the vehicle didn't need charge at that moment in time.
- When plugged into a public or other non-EO infrastructure charging point, the Fleetcarma tracker knew a vehicle was being charged, so sent signals to EO but could not be paired with a charge post because it was not connected to an EO charge point.

These issues were resolved over time through coordination with EO Charging and Fleetcarma. However, they are worth highlighting for any fleet operators seeking to electrify their fleets. Integration of tracking and charging systems allows for greater oversight of the fleet and more efficient management of the operation but considerable effort may be needed to achieve successful integration of disparate systems.

The Future of Electric Vans

This trial has successfully shown the benefits of larger electric delivery vans in London. However, barriers still remain to increasing the uptake of larger electric vans in general within London. These include: charging infrastructure, cost and availability (as detailed in the Key Barriers report). This section outlines what is needed to overcome the main barriers which still exist for accelerated uptake in electric vans to occur.

Infrastructure needed to support future potential

Gnewt Cargo's deployment of EO Hub smart charging infrastructure in the depot meant that existing and trial EVs never needed to use public charge points to meet their operational requirements.

During the trial, Gnewt Cargo's EVs completed their delivery rounds using only 10 kWh, which did not exceed the battery size of any EVs in the fleet (40 kWh for the Vic-Young, 22 kWh for the Voltia and 60 kWh for the BD Auto eDucato). There was no requirement to recharge during the working shift assuming the vehicle left the depot with over 20 kWh of charge.

For fleet operators without a depot (where charging points can be installed) or with delivery profiles that exceed the range of their vehicles, the challenge of how, when and where to charge is a serious impediment to the uptake of EVs.

Current Charging Infrastructure

Public charging infrastructure offers the potential for EVs to maintain and top up charge during operation without returning to a depot. Government policy and the rise of private EV sales has led to an increase in the deployment and use of public EV charging points. As at February 2020, there are 7,801 charging connectors in Greater London[11].

Available charge points in London support a broad range of charger plugs and connections to provide rapid, fast and slow charging services (see *Charging Infrastructure Grid Report* for more details). Depending on the provider and network, charging infrastructure can generally be accessed through options such as pre-paid/pay-as-you-go services, subscription services, or as free-to-use chargers.

The availability of public charging may be important for other distribution companies with vehicles that travel greater distances, carry different payloads or have different power requirements. This is also an important consideration for Gnewt Cargo if it aims to expand its area of coverage or stem mileage.

[11] Source: Zap-Map *https://www.zap-map.com*

Location and Access
Opportunities for using public charging infrastructure depend on the starting point of the EV, the delivery route and (if required) the corresponding charging detour. Public charging facilities are currently provided in car parking structures, on-street parking bays, service stations, or as part of the destination facilities.

Future Charging Infrastructure
Over the duration of the project, stakeholders have highlighted that there are still not enough on-street charge points accessible to larger electric vans. To prevent operation disruption there must be multiple, conveniently placed, on-street charge points accessible to cargo EVs and in residential areas.

Currently, Transport for London estimates that of the circa 281,000 journeys made daily by commercial freight vehicles, the majority of these are diesel fuelled. If these vehicles were replaced by EVs, as outlined in the Department for Transport’s Road to Zero (R2Z) strategy for 2035, there would be over 112,000 EVs on London streets.

The practical implementation of charging infrastructure to support an EV fleet of this scale faces several barriers, including: high costs associated with installing on-street charging due to high land value for parking spaces; safety concerns over the increased numbers of cables and wiring necessary for on-street charging; and high costs and slow charging times of new induction charging technologies.

Solutions for these challenges have been proposed by stakeholders and several government initiatives are spearheading the push towards increasing public charging infrastructure.

Increasing battery capacities will extend the range of EVs, reducing the frequency of required charge. Therefore, it is important for infrastructure developments to upgrade and ensure that the charge points being installed are not made redundant by fast paced technological change.

The impact of large-scale electric van adoption on London UK Power providers and potential mitigation strategies

A challenge facing Distribution Network Operators is knowing where and when to make upgrades on the grid, with the current gap between identification and implementation being two to three years.

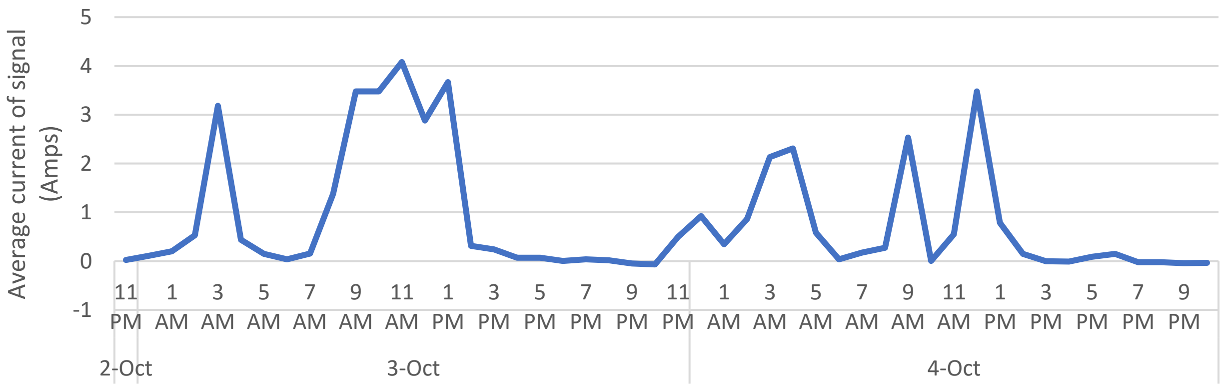
It has been suggested that government policy direction should promote grid upgrades as a benefit to the land, with regulation stipulating that connections cannot be downgraded. This may encourage fleet operators to install EV charging infrastructure in their private or leased depots. In London, this is currently being investigated by the Mayor's EV Taskforce, formed in 2018.

Using operational data gathered over the two-year project span, it was possible to analyse the grid and network implications of large EV uptake by a London delivery van fleet. This section details the grid impact of the project trial and evaluates Gnewt's smart charging infrastructure as an avenue to support future expansion and provide local grid benefits.

Gnewt Depot Site Charging Routine
Gnewt Cargo's Bromley-by-Bow depot uses smart charging technology (see *Charging Infrastructure and Grid Analysis Report refresh* for detailed description of connections).

The smart charging commands were analysed at second by second resolution over two days. The hourly average change was taken of the commands sent throughout the 2 days and plotted in Figure 3. It was found that for the majority of the time the smart charging is being used to increase the load at times that are usually low power on the site. By charging at time periods of low site demand less charging is needed in future when the overall site might have a high demand. Without this capability larger fleets would not be fully charged with the available dwell time.

Figure 3 shows the hourly average of the signalled smart charging signals



The other way that the smart charging minimises the peak load is by directly reducing the charge rate at peak times. These occurrences are far less frequent as they only arise when the capacity could be exceeded.

Gnewt Cargo smart charging grid implications
The site has a grid connection of 120 kVA. Upgrading the grid connection to 200 kVA would increase the standing charge by £103 per month[12]. Beyond 200 kVA would require a new substation and other changes to the local network. This additional cost would be prohibitive and make the scheme uneconomical, demonstrating the importance of smart charging.

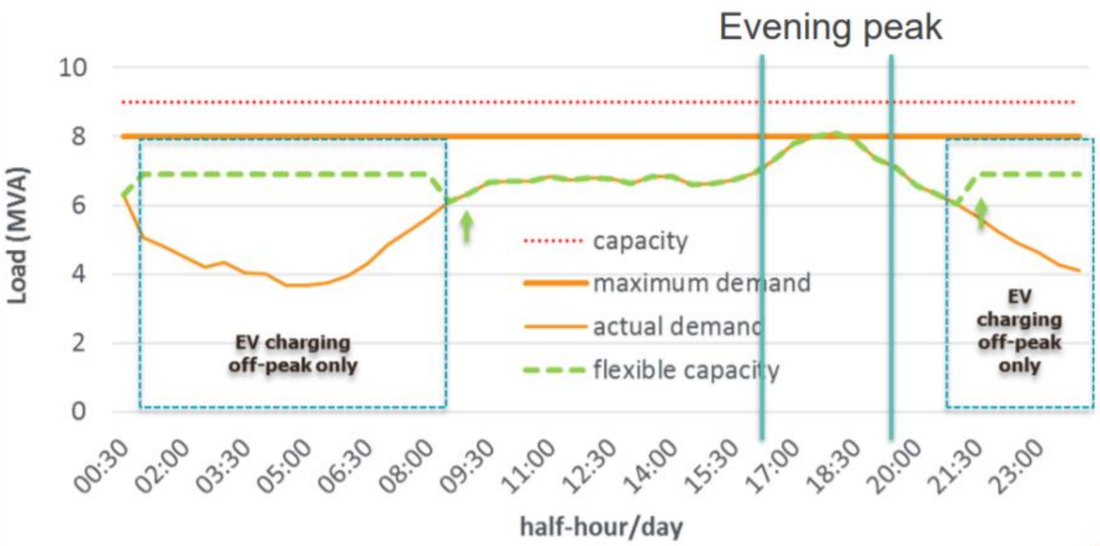
The local Distribution Network Operator (DNO) is responsible for ensuring there is adequate capacity in the area.

For London and the Gnewt Cargo area, UK Power Networks (UKPN) is the DNO, whose responsibility it is to proactively plan for an increase in EVs being charged on the local network.

Figure 4 shows a UKPN typical demand profile for London, which approximately matches that of the Gnewt Cargo site.

This correlation of demand results in more stresses on the grid infrastructure because the peak for the local infrastructure is increased.

Figure 4 UKPN profile derived from material on EV integration available (here)



[12] Using the British Gas business deemed standing charge for London low voltage connection at 4.17 p/kVA, 2019.

Potential for Reverse Grid Charging

In addition to minimising adverse effects on the grid through smart charging, EVs have the potential to assist with grid regulation and access additional revenues through vehicle to grid exports (V2G) if connected to smart chargers with the ability to export electricity to the grid.

Although the concept of vehicle to grid connection has been tested in pilot projects, several technical, commercial and regulatory challenges need to be overcome to make it a viable proposition to EV fleet owners. Given the current challenges and potential benefits, a variety of industry stakeholders are working together to develop a viable proposition.

Recently, the Department for Business and Industrial Strategy (BEIS), in collaboration with the Office for Low Emission Vehicles (OLEV) and Innovate UK, announced £30 million of funding to develop the business proposition and core technology around V2G.[13]

The projects will comprise eight feasibility studies, five collaborative R&D projects and eight demonstration projects, bringing together vehicle manufacturers, aggregators, infrastructure operators, energy suppliers and academia from across the UK.

The installation of Vehicle to Grid (V2G) charge points at the Gnewt Cargo depot was completed in October 2019, after the end of the trial data collection period. Analysis of their operation is out of scope for this trial.

The V2G capability should enable Gnewt Cargo to eliminate their demand on the UKPN grid during peak hours. The initial analysis shows that once fully optimised this will be possible within the site capacity constraints. The V2G capability realisation work is being led by DREEV (Nuvve/EDF consortium).

Business cost implications: Leasing vs purchasing financial case

To understand the potential commercial implications of increased electric van uptake, it is important to consider the various costs associated with the ownership and operation of EVs. The two routes to obtaining larger commercial EVs (outright purchase or leasing) both entail challenges.

- High outright purchase cost – As an example the Renault Master diesel costs from £26,350 in comparison to the fully electric version Renault Master Z.E. which

[13] Upside Energy: https://upsideenergy.co.uk/2018/01/28/upside-energy-wins-three-vehicle-to-grid-projects/.

currently costs from £57,040[14]. A discrepancy of over £30,950 for a vehicle with no greater range or capacity.
- Leasing – Traditional Leasing companies lack substantial experience of leasing commercial EVs. Consequently, many leasing companies are still cautious about entering the market, thereby reducing the options to potential customers. There are specialist electric vehicle leasing companies, such as DriveElectric, which do have experience in this market.

Currently, the outright purchase cost of a larger commercial EV is higher than the equivalent diesel. However, the gap is closing with companies, such as Arrival, working to deliver an electric model that is closer[15] in price to a diesel model. Industry stakeholders believe that at present the comparable cost to a diesel equivalent means that drivers, especially those who are self-employed owner-drivers, are reluctant to invest in a new electric van.

The typical leasing period for commercial vehicles of 5 years is also an area that industry stakeholders believe requires review in relation to EVs. The 5-year timeframe is historic and based on the reliability of diesel vehicles, where they typically experience greater likelihood of developing problems at this point and are sold.

EVs however have greater reliability at the 5-year point. Therefore, the potential to offer a 7-year lease or options to extend the standard 5-year lease were raised at an Advisory Group meeting by stakeholders as needing consideration by leasing companies.

For costs related to the Gnewt Cargo EV trial see the *Operational Costs and Environmental Benefits Report* and *Operational Costs and Environmental Benefits Assessment Update Report*.

Solutions to overcoming the specifics of the leasing versus purchase financial case include;

- Trials of EVs offered to interested operators
- Education and nudge behaviour could be used to provide general information to self-employed van drivers about EVs and promote their lower running costs and environmental benefits.

[14] www.Renault.co.uk (correct as at 14/02/20)

[15] 'Closer' is not quantified as price details were not available at the time of this report

- Uptake levels could be increased further using marketing campaigns to highlight what action fleet operators have taken to move from diesel vans to adopting EVs.
- Another tactic would be targeted engagement with customers of delivery companies to create a bottom-up demand for delivery service providers to use EVs in their fleets.

Availability

New vehicles

One of the major limiting factors to increasing uptake of electric vans in London is the restricted size options available on the market. Currently, operators are turning to conversions (conversion of either an original diesel model into a fully electric vehicle or an existing EV into a model with increased capacity) to address the shortage of available original manufacturer produced models. EVs above minimum capacity 8 m^3 (2.5t to 3.5t) tend to be custom built with a lead time of >6 months[16].

At present many of the larger EVs (such as the Nissan Voltia eNV200) are manufactured by multiple stakeholders (original manufacturer & fabricator/converter) dispersed across multiple countries. This geographic spread can also add delay caused by additional administrative overhead. It is unknown how long conversions will remain prevalent or at what point original manufacturers supply will meet demand.

Mercedes and Volkswagen released their eSprinter and eCrafter models, respectively, at the end of 2019. However, there remains uncertainty in the sector that sufficient volume will be available to the UK market to satisfy demand. As an illustration of this, an industry stakeholder reported that a leading manufacturer allocated just 12 of their new EV model vans to the UK market in 2019.

Political factors and government schemes across Europe have had a direct impact on the availability of electric vans in the UK.

One leading manufacturer for a European market directs volume of new electric vans where it is most commercially advantageous. Countries that offer enticing EV subsidies (Norway) or that specifically promote the use of EVs (Germany, Netherlands) see a greater share of the available vehicles diverted to their market.

---

[16] Based on the experience from this trial

Second-hand vehicles

The second-hand market for commercial EVs is currently very small, with around 400 new registrations in 2015[17]. Due to the high vehicle reliability and lengthy Return On Investment (ROI) period required (because of low margins in the logistics sector) coupled with a small original market, very few second-hand commercial EVs are currently available.

Batteries

As the global demand for alternatively fuelled vehicles increases so does demand for the batteries needed to power them (see *Key Barriers Report* for further information).

[17] Industry stakeholder at Advisory Group meeting

Conclusions

The Mayor of London / Gnewt Cargo Project (which ran from July 2017 to December 2019) examined the performance of modified, larger[18] electric vehicles (EVs) used for delivery and logistics purposes in London.

By trialling new, larger electric vehicles used for delivery and logistics purposes in London, and through collaboration with Innovate UK, MOL, Gnewt, and other key stakeholders, this project has generated key insights around the practical adoption of EVs by fleet operators and the city's ability to support this.

It is concluded that, in terms of operational performance, cost, vehicle emissions and impact on the grid, cargo EVs offer an operationally competitive and environmentally friendly fleet alternative to traditional diesel vans.

In terms of fuel efficiency and operational competitiveness, data revealed that trial EVs were up to five times more fuel efficient than their equivalent sized diesel counterparts and delivered up to 53% more parcels per week than smaller EVs. Furthermore, analysis revealed that despite range concerns, the larger trialled EVs were more than capable of completing last mile delivery operations, returning to the depot at the end of a full day having expended only 30% of charge on average.

Analysis on the impact of Gnewt's EVs on London's grid demonstrate that, thus far, charging requirements can be met by the existing network. Through the adoption of smart charging, fleet operators can realise significant advantages (increase capacity without grid upgrade, load management, charging at financially optimum times). Smart charging also offers potential benefits to the local grid (reduced grid upgrade requests, smoothing of demand).

Although introducing suitable infrastructure to support the uptake of cargo EVs by London fleet operators is a challenge, the UK government have committed funding to help accelerate the roll-out through the launch of the Charging Infrastructure Investment Fund[19]. As infrastructure changes to suit these ambitions, London's delivery fleet operators should begin considering their transition to low emission fleets.

This report is intended to be used as a resource for those deliberating the benefits, drawbacks, challenges and opportunities provided by the incorporation of cargo EVs.

[18] 7.5-13m^3 capacity

[19] R2Z strategy, provides funding to new and existing companies that produce and install charge points

Appendix A

Gnewt Cargo Vehicle Matrix

		CURRENT ELECTRIC VEHICLES		TRIAL DIESEL VEHICLES		TRIAL ELECTRIC VEHICLES		
Vehicle Info	**Vehicle Ref.**	Renault Kangoo	Nissan eNV200	FIAT DUCATO	NISSAN NV200	Nissan Voltia e-NV200	Nissan – Vic Young modified eNV200	BD Otto e-Ducato
	Trial Period	N/A	N/A	01/08/17 - 31/08/17	01/08/17 - 31/08/17			
	Vehicle Picture							
	Vehicle Registration Number	LYI4 HZG	LC64 FKF	SK66 XLJ	BK66 VMO	BK66 VMO	BK66 VMO	N1-L4H2
Vehicle Category & Dimensions	**Vehicle class**	N1	N1	N1 Light commercial vehicle	N1 Light commercial vehicle	N1	N1	N1
	Make	RENAULT KANGOO	NISSAN	FIAT DUCATO	NISSAN	NISSAN	NISSAN	BD
	Model	Kangoo Z.E.	eNV200	Ducato 35 Multijet	NV 2000	e-NV200	e-NV200	e-Ducato
	Vehicle Gross weight (kg)	2146kg	2220	3000 (kg)	2000 (kg)	2000 (kg)	2220 (Kg)	3500 (Kg)
	Bodywork type	2 AXLE RIGID BODY	2 AXLE RIGID BODY	2 Axle Rigid Body. Panel van with body length and height extension, sliding doors on both sides, rear full height twin doors	2 Axle Rigid Body. Panel van with body length and height extension, sliding doors on both sides, rear full height twin doors	2 Axle Rigid Body. Panel van with body length and height extension, sliding doors on both sides, rear full height 60-40 doors that open 180 degrees.	Nissan eNV200 body but potentially fitted with a range of inerior and rear closure options.	
	Overall vehicle dimensions - Length / width / height (mm)	4282, 2138, 1844	4560, 1755, 1858	4693 / 2050 / 2254	4400 / 1690 / 1860	5030/1760/2420	5195/1800/2400	6366/2050/2522
	Cargo space dimensions - Length / width / height (mm)	1476, 1129, 1251	2040, 1500, 1358	2670 / 1870 / 2524	2040 / 4500 / 1360	2500/1500/1900	4800/1800/2500	4070/1870/1932
	Payload volume (m3)	3.4	4.2	8.0	4.2	7.5	8	13
Supplier Information	**OEM/Manufacturer and location**	Maubeuge, France	Barcelona, Spain	Val di Sangro, Atessa, Italy	Barcelona, Spain	Bratislava, Slovakia	England , United Kingdom	Istanbul,Turkey
	Build time/Lead time for delivery	3-4 months	3-4 months	2 months	2 months	N/A		N/A
Cost	**Purchase Price**	£16,313 (+VAT @ 20% £3,262) Total = £19,575	22,6333 (+VAT @ 20% £4,526) Total = £27,160	£18,795 (+VAT @ 20% £3,759) Total = £22,554	£16,185 (+VAT @ 20% £3,237) Total = £19,422	£16,185 (+VAT @ 20% £3,237 + Voltia expansion) Total = £27,000 - £30,000	£16,185 (+VAT @ 20% £3,237 + VY expansion) Total = £25,000 - £30,000	
	First Year VED	£0	£0	£210	£295	£0	£0	
	Lease cost	£240	£240	£230	£200	£500	£500	£3250 pm (exc VAT)
	Minimum lease term	3 years	3 years	3 years	3 years	3 years	3 years	
	Itemise running costs	£480 (est)	£480 (est)	£2,880	£2,300	£480 (est)	£480 (est)	
	Maintenance cost	£120	£120	£160	£160	£160	£160	
	Tax band	E	A	K	E	E	E	
	Insurance Group and cost	13e/£1,800 (per annum)	22/£1,800 (per annum)	5/£1,800 (approx/per annum)	11E/£1,800 (approx/per annum)	11E/£1,800 (approx/per annum)	11E/£1,800 (approx/per annum)	
	Safety features	ABS with EBD (Electronic Brake force, Distribution), Alarm, Airbag - driver, Spare wheel / tyre repair system (Crew, Van Z.E.), Full steel Bulkhead (Not applicable on, Kangoo Crew Vans), Height-adjustable driver's seat, Deadlocking, R.A.I.D (Renault Anti Intruder Device), ESC (Electronic Stability Control) with Hill, Start Assist and Grip Xtend (1), Electronic immobiliser, Remote central locking (2 button key), Front and rear disc brakes, 150 Amp alternator	ABS with EBD (Electronic Brake force, Distribution), Driver airbag, Electronic Traction Control, Immobiliser, Remote central door locking	3-point belts with retractor for cab seats, Head restraints adjustable for height for cab seats, 4-sensor ABS + EBD (brake force distributor), Driver airbag, ASR anti-skid control, MBA mechanical brake assistance (Modular brake assistance), Protective cyclist bar, ESP (Electronic Stability Program), Passenger(s) airbag(s), Front side airbags + window bags	ABS with EBD Brake assist, Vehicle Dynamic Control (VDC), Driver, passenger, side and curtain airbags, Nissan Anti-Theft System Immobiliser, Remote central door locking, Thatcham approved alarm system, super locking, ISOFIX Child-seat anchorage points (2nd row outer seats), Shielded door locks, spare wheel, Tyre Pressure Monitoring System.	ABS with EBD Brake assist, Vehicle Dynamic Control (VDC), Driver, passenger, side and curtain airbags, Nissan Anti-Theft System Immobiliser, Remote central door locking, Thatcham approved alarm system, super locking, ISOFIX Child-seat anchorage points (2nd row outer seats), Shielded door locks, spare wheel, Tyre Pressure Monitoring System. Reversing Camera installed. Anti-slip wooden floor	ABS with EBD Brake assist, Vehicle Dynamic Control (VDC), Driver, passenger, side and curtain airbags, Nissan Anti-Theft System Immobiliser, Remote central door locking, Thatcham approved alarm system, super locking, ISOFIX Child-seat anchorage points (2nd row outer seats), Shielded door locks, spare wheel, Tyre Pressure Monitoring System.	
Engine & Transmission	**Engine**	Electric motor – Synchronous AC motor	EM57 - AC Synchronous	Euro 6	Euro 6	EM57 - AC Synchronous	EM57 - AC Synchronous	Asynchronous water cooling
	Max Power bhp @ rpm (engine power kW)	44	80	Diesel, 130 @ 3600	Diesel, 90 @ 4000	80	80	140/191 (kW/PS)
	Cylinder Capacity	0	0	2287 cc	1461 cc	0	0	
Transaction Battery & Charging	**Type**	Lithium-Nickel-Manganese-Cobalt (LiMiNmCoO)	Laminated lithium ion	N/A	N/A	Lithium ion		Lithium-Ion
	Weight (kg)	260	?					
	Capacity (kWh)	33	14			22	40	62
	Charging time (hrs.)	9	7			Rapid: 50min/wall:7.5 h/domestic:21h	Rapid: 50min/wall:7.5 h/domestic:21h	three phase: 7h/single phase: 8-16h

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.