MAYOR OF LONDON

Mayor of London / Gnewt Cargo Electric Vehicle Trial

Operational Costs and Environmental Benefits Assessment

Originally written: March 2018

Updated: October 2019

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

The Mayor of London / Gnewt Cargo electric vehicle (EV) trial project, which runs from July 2017 to December 2019, examines the impact of electric vans used for delivery and logistics purposes in London using a range of logistical, environmental and economic performance factors.

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

This report outlines the operational costs and environmental benefits of using an EV fleet compared to a traditional diesel engine fleet. It weighs up the monetary, socio-economic and environmental factors involved with implementation of EV fleets based on Gnewt Cargo's operating model.

The costs and benefits were evaluated from the perspectives of both the commercial operator and the public regulator. Overall findings indicated that EVs had a significantly lower cost when assessed per kilometre, as well as significantly lower average fuel associated emissions per kilometre. From this it could be concluded there are potential financial and socio-economic benefits of adopting EV fleets for both commercial and public stakeholders.

Gnewt Cargo Trial Project Background

At present EV fleets tend to comprise purpose built small cars and small vans (capacity maximum 4.2 m^3). There is a limited production and uptake of larger electric vans (minimum capacity 8 m^3). Put another way, there are currently few EV equivalents to the Mercedes Sprinter (capacity 8.5 m^3/ payload 1,035 kg). This is in part due to the low production/demand loop. A reaction to this shortfall is the customised build of EVs but these vehicles can be expensive to produce and purchase. This project examines the benefits/disbenefits of the introduction of larger EVs to London's road and power networks.

The establishment of a baseline is the first phase of the overall project, which is designed to deliver comprehensive monitoring and evaluation of the effects of the trial. These impacts will be 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 as well as quantifying the size of the business opportunity for scaling up the project.

The new EVs, which are the subject of this trial, are the Nissan Voltia eNV200 (capacity 8m^3) and BD eDucato (capacity 13m^3). Additional Nissan eNV200 (modified) vehicles are expected to be added to the trial fleet in April 2019. To evaluate the performance of these new larger electric vans they were compared with Gnewt Cargo's EV fleet of four Nissan eNV200s and 39 Renault Kangoo light goods vehicles (LGVs).

To establish the baseline, Gnewt Cargo Ltd hired two diesel vehicles (Fiat Ducato and Nissan NV200) and fitted them Fleetcarma fleet telematics system. The diesel hire vehicles were operated from 1st August to 15th September 2017 and carried out deliveries in the following areas across London: Tottenham Court Road / Goodge Street / Fitzrovia, Liverpool Street / Moorgate. It was agreed during the project kick-off meetings that these locations provided a representative sample for the different business areas in London, considering various factors, such as congestion and building types.

Additional routes on the original schedule were not used during the trial due to the Fiat Ducato's size; older building infrastructure across some areas of London restrict the size of vehicle that can deliver to a building. This is especially prevalent where there is no dedicated space for short-term parking of 8m^3 capacity vehicles.

Introduction and Context

Market Overview

Gnewt Cargo specialises in delivery of goods using electric and low emission vehicles.

Figure 1: Gnewt Renault Kangoo EV

To understand the commercial and economic case associated with the transition to cargo EVs, a trial was undertaken to help us learn about the relative costs and benefits of operating a traditional fleet of light goods vehicles (LGVs) relative to a fleet of low emission electric LGVs.[1] Gnewt Cargo used three conventional diesel vans (one Nissan NV200, one Fiat Ducato, and one Peugeot Expert) over a six-week period from August 2017 – September 2017 to deliver goods in conjunction with their fleet of 59 EVs consisting of 5 Nissan eNV200s and 54 Renault Kangoo Z.E.

This report provides an assessment of the relative operational costs and emission benefits of introducing electric LGVs across different scales. Firstly, we estimated the per kilometre relative cost of operation and emissions of Gnewt Cargo's electric fleet (Renault Kangoo Z.E. and Nissan eNV200) and trial diesel vehicles (Fiat Ducato 35 Multijet and Nissan NV200). Then we extrapolated these values to calculate the cost variation and benefit implications for:

- The commercial operator (based on Gnewt Cargo business structure) – the relative cost savings of EV operation are considered in three different commercial and adoptive scenarios. Each of the commercial scenarios represent different fleet growth rates that Gnewt Cargo may pursue and the relative cost reduction and accrued benefits of a fully electric LGV fleet against a diesel one.
- The public regulator – preliminary examination of the larger implications and potential benefits to the Greater London Authority (GLA) by encouraging the regional adoption of electric courier vehicles. We have estimated savings in cost operations and environmental benefits at a regional scale for the Greater London area, to understand the commercial and societal implications of various electric LGV adoption trajectories over the appraised period.

[1] Defined by the DfT as a commercial vehicle with 2 axles and a maximum gross weight of 3.5 tonnes

Conclusions are drawn based on data received during the initial Gnewt Cargo trial period (August-September 2017), in conjunction with existing forecasts and parameters provided by the Department for Transport (DfT) around vehicle efficiency and price trajectories.

Electric Vehicles in Great Britain

The EV market is growing rapidly across the private and commercial sector, with the DfT observing a 40% growth in EV registrations Great Britain wide in 2016 over the previous year's levels. Despite this rapid growth rate, the 87,000 EVs registered in the UK (77,000 electric cars and 10,000 others) only represent around 0.3% of the vehicle market.[2]

Figure 2: Number of Electric Vehicle Registrations in the UK[3]

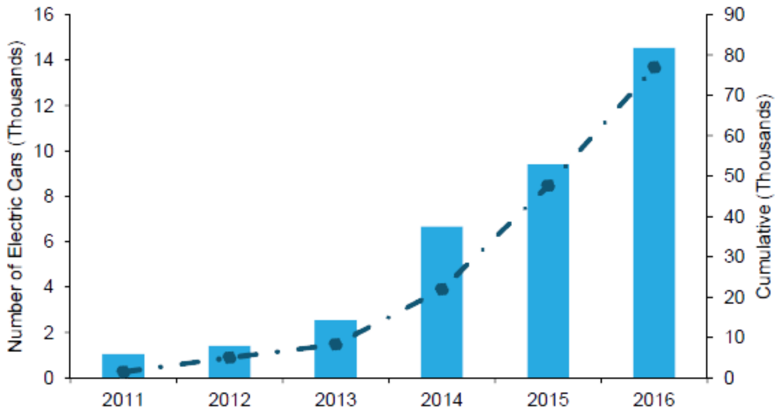


Figure 7: Registrations of Electric Vehicles (cars) in the UK [12]

There are a number of factors driving growth in the EV market. One particularly influential factor is the rapidly decreasing price of battery packs, which allow EVs to better compete with traditional combustion vehicles on lifetime capital and operational expense, including importantly their upfront initial capital cost. According to a 2016 McKinsey and Bloomberg report, "the average price of lithium-ion battery packs used in EVs fell 65% over the period between 2010 and 2015 – from $1,000/kWh to $350/kWh." It is expected that costs will keep decreasing driven by scale improvements in battery chemistry and better battery management systems. Forecasts estimate that prices for EV batteries will drop to a bottom out price below $100/kWh in the next decade.[4]

Increasing affordability and environmental awareness will support the EV market, which is expected to make up 35% of all global new car sales by 2040. In the UK the government

---

[2] DfT Vehicle and Licensing Statistics: Annual 2016

[3] DfT Vehicle and Licensing Statistics: Annual 2016

[4] McKinsey & Company: *An Integrated Perspective on the Future of Mobility* (2016)

has pledged to halt the sale of conventional petrol and diesel cars by 2040, driving significant growth in the hybrid and EV markets.

Furthermore, the adoption of EVs will be driven by lower costs of ownership, which are forecast to fall below traditional fossil fuel vehicles by 2025, even oil prices below $70USD a barrel.[5] Therefore it is important to be conscious that the coming, rapid electrification of transport, will require reliable and growing grid capacity, as well as accessible charging infrastructure.

LGV Fleet in Great Britain

There are currently (2016) 3.8 million LGVs in Great Britain with an annual growth rate of approximately 4%. Of the nearly 4 million LGVs on the road, only 5,300 LGVs are presently EVs (0.1% of all LGVs).[6] The current LGV stock in Great Britain is aging, 53% of all LGVs have surpassed six or more years since their initial registration and the average age of a licensed car or LGV in the UK is 8.2 years[7]

Two identified drivers of growth in the LGV sector include the increasing demand for internet shopping and home deliveries and looser regulation on driver training. In 2016, 77% of adults shopped online at least once in Great Britain, compared to 53% in 2008.[8] In conjunction with the growing trend towards digital commerce, there is looser regulation on driver training, drivers' hours and roadworthiness testing for LGVs in comparison to Heavy Good Vehicles (HGVs). The less stringent restrictions make it easier to find qualified and willing drivers for LGVs, which has in turn encouraged businesses to replace small HGVs with LGVs where feasible. Furthermore, the greater flexibility of LGVs allows them to better accommodate first and last mile journeys that can include narrow streets and constrained roads.

LGV Fleet in London

London, like the rest of Great Britain is experiencing a similar rapid growth in their active LGV fleet. There are 221,000 LGVs registered in the London region with another 638,000

---

[5] Bloomberg New Energy Finance – *https://www.bloomberg.com/features/2016-ev-oil-crisis/*

[6] DfT Road Traffic Estimates: Great Britain 2016

[7] DfT Table VEH0207

[8] Ibid

in the South East and 397,000 in the East of England.[9] According to Transport for London (TfL), LGV volumes in London in 2006 were 13% higher than those of 2012.[10]

Each day there are typically 281,000 commercial vehicle journeys made in London.[11] Furthermore, during the AM weekday peak period, there are 7,300 LGVs active per hour on the streets of Central London. LGV travel through London is split 60% on major roads and 40% on minor roads.

TfL conducts cordon and screen line counts to monitor patterns in traffic flow and growth over time.

[9] Ibid

[10] London Assembly Transport Committee investigation into light commercial traffic (2016)

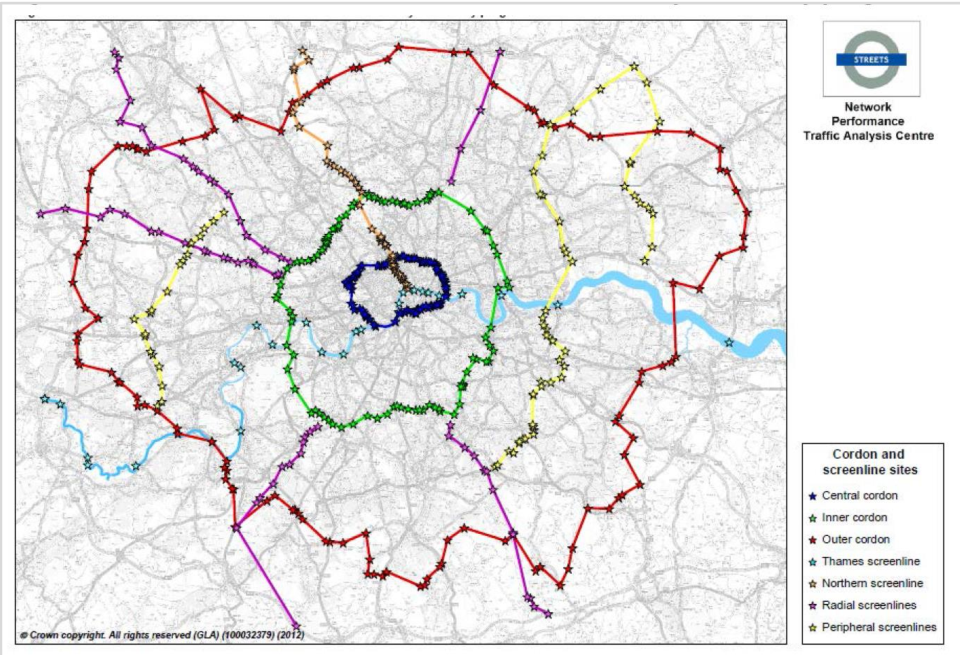
[11] TfL Freight & Fleet Programmes. Sustainable delivery and servicing – Lessons from London (2015)

Figure 3 shows the coverage of the cordon rings and spread of survey points for vehicle crossings in the London region. This research indicates the number of goods vehicles crossing in and out of London has risen significantly over the past decade. Outer cordon boundary crossings in 2012 were approximately 15% above 2002 levels at roughly 350,000 daily vehicle crossings.[12] Inner London and Central London boundary crossings were approximately 290,000 and 170,000 per day, respectively, in 2012.[13] The number of Central London boundary crossings remained relatively stagnant over the past decade despite regional disincentives and restrictions. In particular, the application of congestion charging and the reduction of general road capacity with the implementation of additional cycling infrastructure and dedicated bus lanes will further restrict LGV capacity. It is predicted that the impact of LGV growth will most heavily affect Central London.

[12] TfL London Freight Data Report (2014)

[13] Ibid

Figure 3: Cordon Count Sites Monitored by TfL Survey Programme[14]



Environmental Impact of Current LGV Stock

The existing LGV stock is a significant contributor to poor air quality and greenhouse gas emissions in London. In 2010, the emissions of LGVs in London contributed 10, 12 and 22% of the total emission levels of CO_2, NO_X and PM_{10} respectively.[15] The planned introduction of the Ultra-Low Emissions Zone in London in 2019 will likely put more pressure on vehicle manufacturers and businesses to shift towards electric or upgrade to newer diesel vehicles which comply with ULEZ requirements.

With Central London anticipating further growth in LGV traffic over the next decade (2019 - 2029), associated air-quality pollution and greenhouse gas (GHG) emissions are set to increase. This increase in pollutants will be in an area of London which is already near to or exceeding EU annual mean limit values of 40 ug/m3 for NO2 concentrations.[16]

---

[14] London Freight Data Report: TfL (2014)

[15] Ibid

[16] London Air Quality Network: londonair.org.uk

Awareness of the environmental impact of goods delivery is becoming increasingly widespread and is resulting in a greater consumer emphasis on environmentally friendly delivery methods. Nearly half of respondents to a recent GLA survey stated, “the sustainability of the transport mode being used to deliver their goods mattered a lot.”[17]

[17] London Assembly Transport Committee Investigation into Light Commercial Traffic (2016)

Parameters and Methodology

The baseline travel data used for defining the associated commercial and socio-environmental implications of electric, versus diesel powered LGVs is generated by Fleetcarma Telematics as part of the Gnewt Cargo EV trial. The Fleetcarma data set measures the performance of three diesel cargo vehicles and 59 electric cargo vehicles, providing real time information on distance travelled, fuel consumption, efficiency and emissions.

The study data is used in combination with vehicle registration and mileage figures from the DfT and TfL, as well as emissions valuations from the Government to extrapolate the results for various levels of analysis.

Extrapolating information from the Fleetcarma data, in conjunction with relevant parameters outlined by the DfT and TfL, allow us to understand the larger potential implications of electric cargo vehicle adoption across the London region. The underlying assumption is the measured activities of Gnewt Cargo reflect those of a typical LGV cargo fleet in the Greater London area.

In terms of the baseline model assumptions, we have considered a ten-year appraisal period (2017-2026) and a discount rate of five%, this is reflective of HMT Green Book Guidance for a social discount rate including health and life effects.[18]

Commercial Parameters and Assumptions

To understand the potential commercial implications of electric LGV adoption it is important to consider all the various costs associated with the ownership and operation of LGVs. Table 1 lists various direct costs of ownership associated with both electric and diesel cargo vehicles.

[18] Appraisal period from January 1, 2017 through December 31, 2026 inclusive.

Table 1: Cost Parameters of Commercial LGV Operation

Cost	Data Source	Measurement
Lease Cost	GNEWT CARGO	£/month
Maintenance Cost	GNEWT CARGO	£/year
Running Cost	GNEWT CARGO	£/year
Vehicle Tax	GNEWT CARGO/DfT	£/year
Insurance Cost	GNEWT CARGO	£/year
Fuel Cost	BEIS	£/Litre & £/kWh
Fuel Usage	GNEWT CARGO	km/Litre & km/kWh
Congestion Charge	TfL	£/day

The operational cost and benefit analysis incorporates different commercial assumptions. The assumptions help to extrapolate the trial data to make conclusions about the potential future impacts of EV adoption for commercial operators and government regulators.

It is presumed that all associated labour costs and most significant infrastructure costs (including depot space, building services costs, maintenance and repair facilities) would not be significantly affected by the transition between a diesel and electric vehicle fleet.

Fuel Cost and Efficiency

To incorporate the predicted changes in fuel efficiency and cost over time we rely on the fuel price and vehicle efficiency forecasts provided by the DfT Transport Analysis Guidance (TAG) data book[19] for both electric and diesel vehicles. As seen in

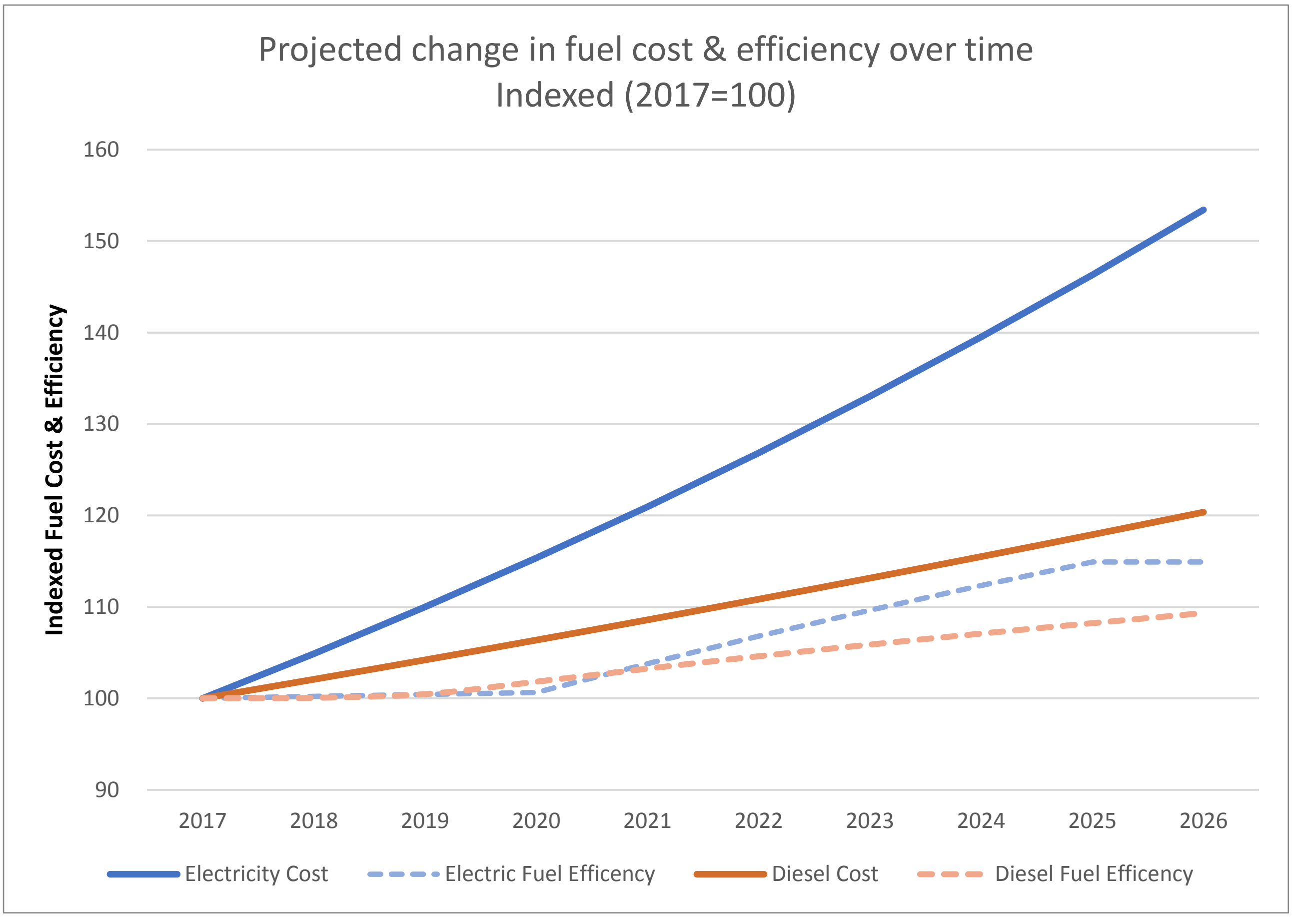
[19] DfT WebTAG Data Book (A1.2.10)

Figure 4, the predicted cost of fuel for both electric and diesel vehicles is expected to increase over time. The growth rate of these projections considers the average increase in electricity and diesel prices in the UK between 2007 and 2016 – 4.87 and 2.08%, respectively.

Similarly, the efficiency of both diesel and EVs is expected to continually improve over the coming decade, with an average rise in efficiency per annum of 1.52% for EVs and 0.98% for diesel vehicles.[20]

[20] DfT WebTAG Data Book (A1.2.10)

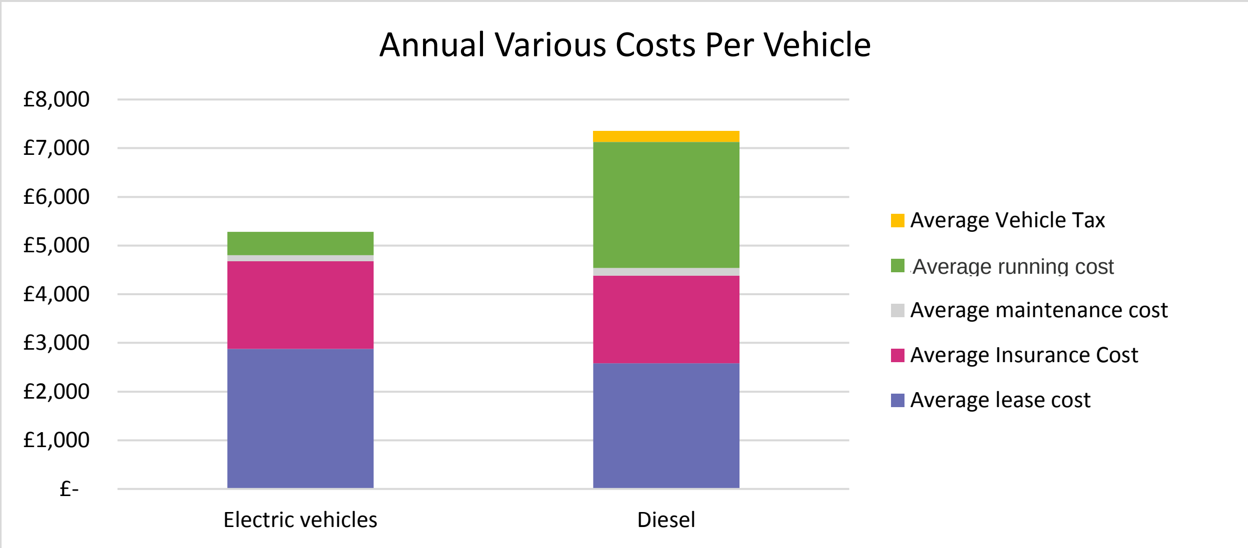
Figure 4: Projected change in fuel cost and efficiency over time[21]



Non-Fuel Vehicle Operation and Capital Costs
In order to account for non-fuel operation and capital costs, we have considered various annual costs provided by Gnewt Cargo Ltd – which include vehicle tax, itemised running costs, maintenance, insurance and lease costs. Figure 6 summarises these annual costs for both electric and diesel vehicles. The largest difference in the various costs of diesel and electric vehicles can be seen in the "average running cost." Included in this cost category is the London congestion charge, which is not applicable to EVs, and therefore accounts for a significant portion of the variation in this category. For more information on the various costs associated with different vehicle types, see **Error! Reference source not found.**.

[21] Source: DfT WebTAG Data Book 2017

Figure 5: Annual Various Costs per Gnewt Cargo Vehicle[22]



Socio-Environmental Considerations

A keystone benefit of the increased market penetration of EVs, is the reduction in the level of GHG and other pollutants which contribute to poor air quality, such as nitrogen dioxide and fine particulates, which are traditional by-products of fossil fuel powered internal combustion engines. This consideration is particularly important in an urban environment like London, where there is a large population and a high level of vehicle traffic, resulting in potentially significant exposure to air pollution.

To appropriately calculate the value of the environmental benefit from the reduction of emissions created by replacing traditional vehicles with EVs, it is important to capture and monetise the various types of vehicle emissions. The DfT TAG data book provides current and forecast GHG emissions (grams of CO_2 equivalent) per litre of fuel consumed for diesel vehicles and per kWh of electricity consumed for EVs. Using the DfT metrics in conjunction with the fuel efficiency data provided by the LGVs in the Gnewt Cargo trial allows us to determine the average emissions of diesel and electric vehicles per kilometre over time (See

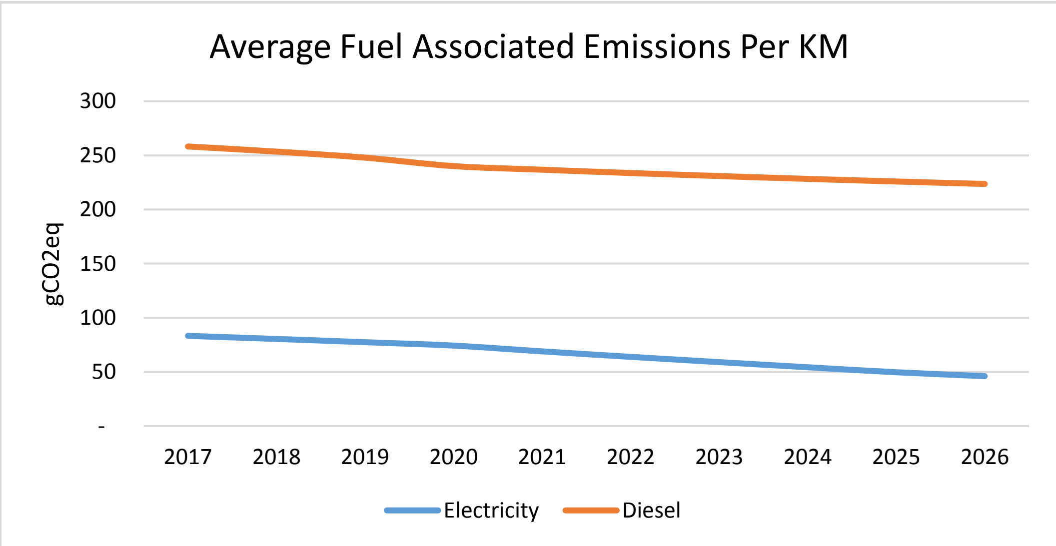
Figure 6).

[22] Source: Gnewt Cargo

The current energy use economy of an EV is 26kWh per 100 kilometres based on the data collected during the Gnewt Cargo trial period.

The trial data for diesel fuel economy was insufficient to create an appropriate fuel economy metric[23]. As a result, we use data provided by the Vehicle Certification Agency based on the NV200 trial diesel vehicles to calculate a diesel LGV fuel economy of 10.1litres/100km.[24]

Figure 6: Average Fuel Associated GHG Emissions per Kilometre



It is often assumed that EV are zero emissions because they remove entirely the emissions of GHG and local air pollutants associated with traditional combustion vehicles. However, it is important that we incorporate the emissions associated with the increased electricity requirement and the associated emissions of electricity production. These emissions will not be produced on the urban roads of London and will resultantly have limited impact on local urban air quality.

The GHG impacts of these emissions remain relevant and important for us to monetise in our analysis. By shifting the production of power to scale at a power station rather than as a product of individual internal combustion engines it is evident there is opportunity for a

[23] Based on data collected from the diesel vehicle trial, we estimated a fuel efficiency ratio of 47litres/100km.

[24] http://carfueldata.direct.gov.uk/#WeightedResults

significant reduction to the overall GHG emissions generated.[25] Furthermore, EVs are more efficient than conventional vehicles, at converting energy in the battery to motion at the wheel.

Figure 6 illustrates that each kilometre driven by an EV results in 66% less GHG emissions compared to an equivalent kilometre driven by an internal combustion engine in 2017.

[25] Important to note here a minor discrepancy in the emissions impact assessment between electric and diesel vehicles. We do not incorporate the emissions associated with the supply of diesel to diesel powered vehicles, however we believe this to be quite minor and would have an insignificant impact on results.

Assessment

Using the trial data provided by Gnewt Cargo in conjunction with the DfT parameters and forecasts, we have undertaken three complimentary assessments which compare the costs and associated benefits of operating diesel and electric LGVs in London. The assessments interpret the information from three discrete levels of analysis: a per kilometre cost, a commercial operator assessment and a wider socio-economic assessment of the implications for Greater London. Each assessment provides a distinct set of findings that are complimentary and allow us to make a set of conclusions.

Per Kilometre Assessment

The total cost per kilometre of electric and diesel vehicles allows us to understand the operational expenditure difference of vehicle types. The per kilometre operational cost can be divided into two distinct categories, fuel cost and other vehicle operation and capital costs.

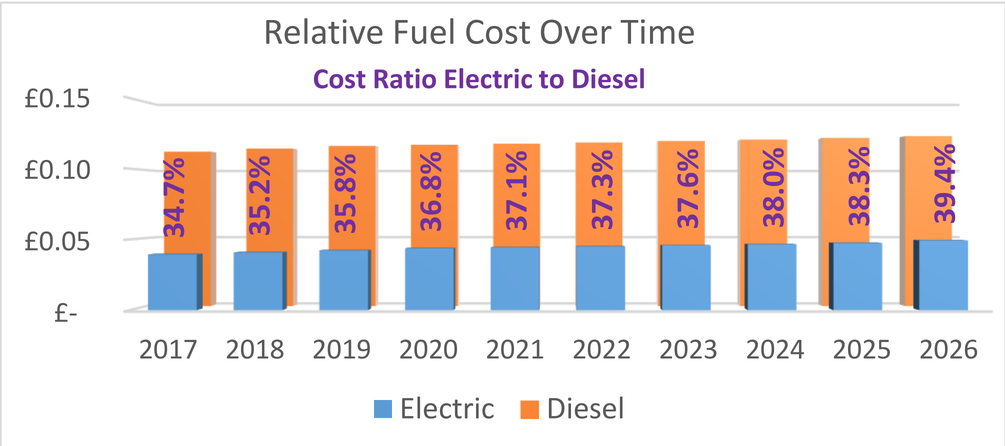
Fuel Costs Per Kilometre

The projected fuel costs of diesel and electric LGVs per kilometre in 2017 are 11p and 4p respectively. The significant difference in per kilometre cost suggests a 65% reduction in overall fuel costs by transitioning from diesel to electric LGVs.

Looking forward, and incorporating the average price increase of electric and diesel fuel in the last 10 years as well as the expected advancements in energy efficiency for both types of vehicles, the relative difference between the cost of diesel and electric fuel is decreasing (see Figure 7).

The findings suggest the avoided fuel costs of transitioning to electric LGVs is decreasing with time, a result tied to assumed steady increases in electricity costs over the next decade that outpace the projected growth in diesel cost over the same period.

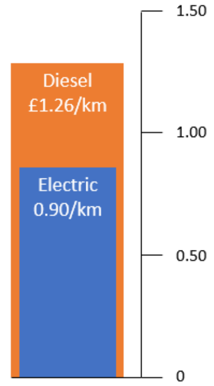
Figure 7: Fuel Cost of Diesel and Electric LGVs



Other Vehicle Costs per Kilometre

Although the difference in the cost of diesel and electricity is significant according to the trial data provided by Gnewt Cargo it is a minor proportion (<10%) of the overall operating expenditure associated with an LGV. Based on the number of vehicles and the total kilometres driven by the trial fleet, there is an operational and capital cost of 126p/km for diesel LGVs and 90p per kilometre for electric LGVs. Therefore, in 2017 the non-fuel operation cost for EVs is 28% below the related cost for diesel vehicles.

Figure 8: LGV Other Cost 2017



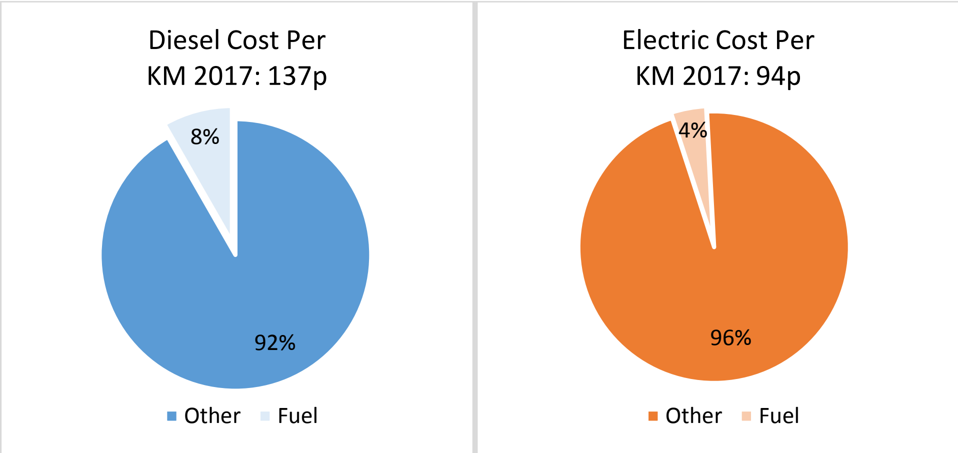
Total Cost Per Km

Fuel costs are 8% of the overall cost of operating a diesel LGV and merely 4% of the overall cost of operating an electric LGV.

Using 2017 values, the cumulative cost per kilometre of operating a commercial diesel LGV in London is 137p per kilometre, 45% more expensive than an EV which costs 94 pence per kilometre to operate (see Figure 9).

Over the next decade, the cost gap between operating a diesel and electric LGV is forecast to gradually shrink over time, however, only by a miniscule margin. With the cost ratio between diesel and electric LGVs narrowing by 0.2% between 2017 and 2026 due to the impact of the anticipated increases in electricity costs.

Figure 9: Total Cost Per KM Diesel & Electric 2017



This per kilometre assessment looks specifically at the direct commercial implications of operating diesel and electric LGVs. When we consider the socio-economic benefits of operating an EV in an urban environment we can include an additional benefit per kilometre. Including the value of the reduction of noise and emissions of both GHG and local air pollutants, results in an additional benefit of 2p per kilometre of EV LGV operations in London.[26] When incorporated into the overall operating cost this increases the discrepancy between electric and diesel vehicles, making a diesel LGV 48% more expensive to operate in 2017, a gap that remains roughly consistent across the appraisal period through 2026.

Commercial Operator Assessment

Forecast Scenarios

We used the trial information and Gnewt Cargo's business structure (type of vehicles, vehicles kilometres, freight routes and so on) as a model to apply potential commercial growth scenarios to understand the benefits attached to the adoption of electric LGVs by private operators.

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

As a baseline, we considered the average distance travelled per week by the Gnewt Cargo fleet (6,955 kilometres) and a week-to-year factor of 52.14[27] to estimate an annual total distance of 362,620 kilometres.

The commercial growth scenarios that were modelled as part of this research, based on stakeholder engagement, are shown in Table 2 and envisage three growth forecasts for a commercial fleet over the next decade.

Table 2: Commercial Operator Fleet Growth Scenarios

Scenario	Annual Growth Rate	LGV Fleet Total Travelled KM		
		2017	**2021**	**2026**
Low	0%	362,620	362,620	362,620
Medium	2%	362,620	392,512	433,365
High	5% to 2021 then 20%	362,620	577,980	1,438,200

Annual Cost Impact

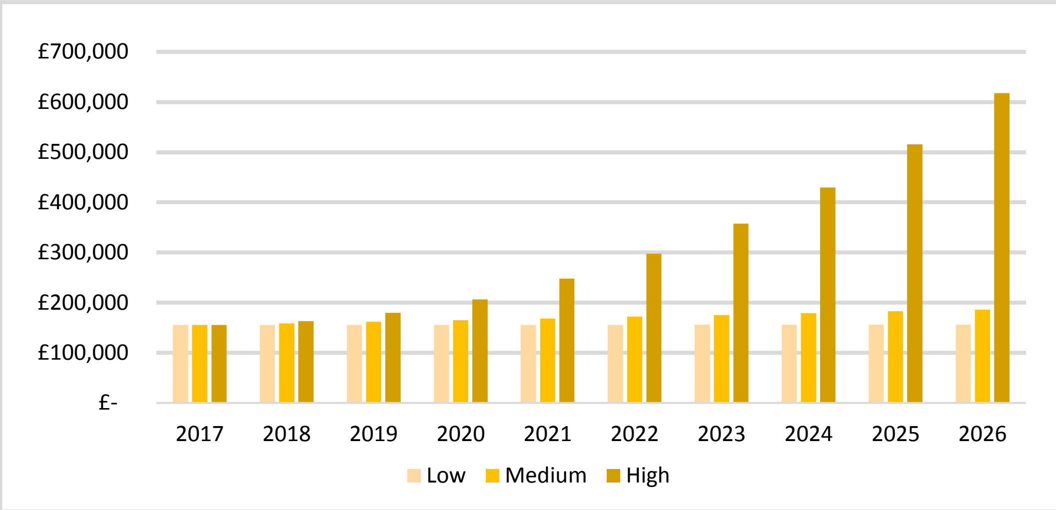
Using these three scenarios to model the difference in operational expense of a diesel LGV fleet and an electric LGV fleet reveals significant operational cost savings. The 2017 operational savings of operating a fully electric fleet are £155,221 – based on a diesel fleet operating cost of £496,873 and an electric fleet operating cost of £341,652. In 2017, the electric fleet operating cost consists of £14,292 in electricity costs and £327,360 in various costs.

At the end of the appraisal period in 2026, depending on the scenario followed, the annual benefits of a fully electric fleet could be as high as £617,949 in comparison with a fully diesel fleet.

[27] In line with the week to year factors used by the National Transport Survey

Even in the low scenario, with zero growth, the annual operational benefit of an electric LGV fleet is forecast as £155,806 in 2026 (see Figure 10).

Figure 10: Annual Operational cost reduction from Electric LGVs, 2017prices



The Cumulative cost reduction of the Electric LGV fleet

The cumulative cost reduction of the different scenarios is shown below in Table 3, both in real 2017 values and discounted net present values (NPV). The cumulative cost reduction by the end of the appraisal period (2026) has an NPV between £1.2 and £2.4 million for the fleet depending on their pursued level of growth.

Table 3: Cumulative cost reduction of Electric LGV Fleet

Scenario	2020		2023		2026	
	Real, 2017 prices	NPV	Real, 2017 prices	NPV	Real, 2017 prices	NPV
Low	£622	£579	£1,089	£945	£1,557	£1,262
Medium	£641	£596	£1,157	£1,000	£1,705	£1,371
High	£705	£652	£1,608	£1,356	£3,171	£2,409
*All values in 000's of 2017£						

Socio-environmental considerations

The values discussed so far in the commercial operator assessment have all been based on the operating costs associated with EV in comparison to their diesel counterparts. There is an added societal benefit of £5,514 in 2017 alone if we factor in the additional value generated by net GHG emissions reductions: emission reductions from vehicles valued at £6,053; minus emissions from electricity generation with a cost of £1,954. This benefit, in conjunction with the reductions in air pollution and noise, generates the overall value of the socio-environmental improvement of operating an electric LGV fleet.

The cumulative environmental benefit of the tested LGV fleet being fully electric over the next decade is an NPV between £46,000 and £90,000 depending on the scenario. While this added benefit is not directly felt by the commercial operator, it is exemplary of the scale of impact that each fleet operator may have on improving the socio-environmental conditions within London.

Greater London Assessment

Forecast Scenarios

To understand the potential implications of various market penetration scenarios for electric LGVs, it is valuable to present the results through a series of scenarios that allows the sensitivity of the results to different market penetration rates to be clearly understood. Table 4 details the presumed future market penetration rates of electric LGVs in London in the three hypothetical scenarios that have been selected for modelling as part of this report. In all three scenarios, we included both the improvement in economic efficiency associated with the operational cost savings of electric LGVs and the societal benefits associated with transitioning fossil fuel vehicle kilometres in London to electric kilometres.

Table 4: London Electric LGV Adoption Scenarios

Scenario	Annual Growth Rate	Electric LGV Market Penetration Level		
		2020	**2023**	**2026**
Low	2.5%	7.5%	15%	22.5%
Medium	3.8%	11.3%	22.5%	33.8%
High	5% to 2021 then 7.5%	15%	35%	57.5%

Based on TfL data[28], we estimate LGVs will be responsible for 3.9 billion vehicle kilometres in London in 2017. We have assumed an annual increase of 0.73 per cent (LGVs vehicle kilometre growth between 1997 and 2012[29]) throughout the appraisal period.

[28] Transport for London, London Freight Data Report: 2014 Update

[29] Ibid

Annual Benefits of Electric LGV Growth

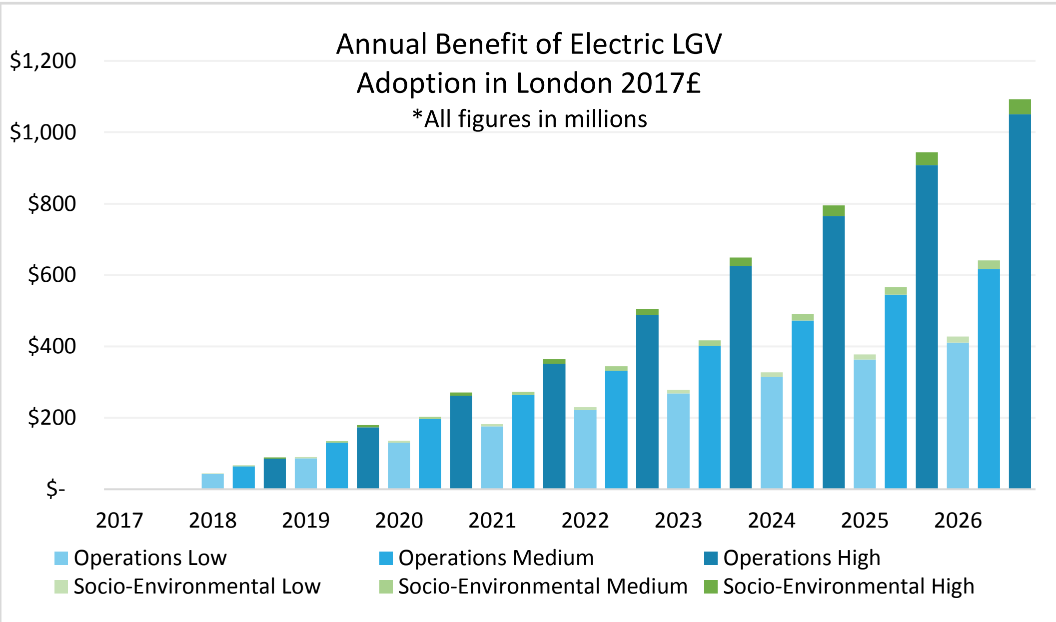
The three adoption scenarios for London provide significant value to the city every year. However, the annual benefit of EV is markedly higher with a more aggressive pattern of adoption.

By 2026 under the high scenario there is an annual benefit of £1.1 billion to London with 57.5% of LGV kilometres driven by EVs.

Under the low scenario with an adoption rate of only 22.5% the annual benefit is 60% lower at £428 million in 2026.

The annual benefits of each scenario throughout the appraisal period are shown in Figure 11. The results are divided between the operations benefit resulting from EV cost savings, and the socio-environmental benefits tied to reductions in emissions of GHG and local air pollutants.

Figure 11: Annual Benefit of Electric LGV Adoption 2017£



The Cumulative Benefit of London Electric LGV Adoption

The cumulative benefits of the different adoption scenarios are shown in

Table 5 in 2017£. There is a large variation in the potential cumulative benefits based on the aggressiveness of adoption of electric LGVs across greater London. The NPV of the cumulative benefit in 2026 ranges from £1.5 billion in the low scenario to £3.6 billion in the high adoption scenario. The operations benefit from EV cost savings account for the vast majority of the total accrued. Their value is 96% of the total cumulative benefit value in all scenarios.

Table 5: Cumulative Benefits of London Adoption Scenarios[30]

Scenario	2020		2023		2026	
	Non-discounted	NPV	Non-discounted	NPV	Non-discounted	NPV
Operations Benefits						
Low	£261	£233	£927	£751	£2,016	£1,486
Medium	£391	£349	£1,390	£1,127	£3,025	£2,230
High	£521	£466	£1,987	£1,604	£4,712	£3,441
Socio-Environmental Benefits						
Low	£9	£8	£33	£27	£76	£56
Medium	£13	£12	£50	£40	£114	£84
High	£18	£16	£71	£58	£178	£129
Total Benefits						
Low	£270	£241	£960	£778	£2,092	£1,542
Medium	£405	£361	£1,440	£1,167	£3,139	£2,313
High	£540	£482	£2,058	£1,662	£4,890	£3,570
*All values in millions of 2017£						

[30] Benefits calculated according to previously specified methodology, DfT WebTAG guidance for transport appraisal, and assumed levels of EV adoption specified in Table 4. All benefit estimates are based on current guidance at the time of publishing.

Relevant Caveats of our Assessment

The findings presented are based on driving patterns and usage levels of the Gnewt Cargo courier fleet and may not be reflective of all LGV operators. However, given the presumption that a vehicle operator will accrue the same vehicle kilometres to complete their necessary commercial obligations regardless of whether they are operating an electric or a traditional fossil fuel vehicle fleet, our findings remain indicative of the outcomes for various commercial operators if scaled to reflect their individual operational levels.

The assessment presented focuses explicitly on comparing the relevant operational expenses of diesel and electric vehicles based on a 3-year lease model. The analysis does not consider the relative capital costs of purchasing different vehicle types outright. It is presumed that all associated labour costs and most significant infrastructure costs (including depot space, building services costs, maintenance and repair facilities) would not be significantly affected by the transition between a diesel and electric vehicle fleet. Therefore, we do not consider the associated labour costs associated with operating an LGV fleet. Furthermore, the assessment does not explore other vehicle types including petrol, hybrid, and those using alternative fuels.

We have not included the capital cost of charging infrastructure in our assessment, given the large variation in cost based on different methods of implementation and operation. For example, some operators may choose to provide a charging point for each vehicle to allow capacity for their full fleet to charge at once, while other operators may choose to rotate their fleet through a smaller number of chargers to reduce the capital cost of charging infrastructure. Similarly, at a city-wide level, there are different charging products and polices that local governments can put forward to roll-out charging infrastructure and support a transition away from fossil fuel-based transport. The investment requirements of these charging products vary significantly from one to another since they are rapidly evolving technologies.

The assessment performed does not consider some of the potential structural business complications with the transition to electric LGVs, for example issues with vehicle range.

With a manufacturer projected fuel efficiency of 10.1 litres per 100 kilometres, the diesel Nissan NV200 has an approximate range of 652 kilometres on a single tank of fuel. Conversely, the Nissan ENV200 used by Gnewt Cargo has a range of 170 km on a single charge according to manufacturing specifications.

The implications of the limited range for EVs based on current battery conditions implies a limited daily travel range for commercial operators aiming to complete a single business day without taking time to recharge electric LGVs.

Based on this particular trial experience, it is concluded that Gnewt Cargo can meet their daily business obligations in London on a single charge and the limited range was not an issue for their business.

This conclusion may not be true of all London LGV operators with their varying business structures and obligations. However, as it has been shown, it is reasonable to assume that a young and rapidly changing technology such as EVs will keep increasing battery efficiency and vehicle ranges in the upcoming years.

Costs Associated with the Gnewt Cargo Trial

Exclusively for illustration purposes, this section outlines the implementation costs associated with the operation of the Gnewt Cargo trial from 2017 to 2019. It is important to qualify that these costs are specific to the Gnewt Cargo trial and are not necessarily indicative of the initial cost of a different fleet operator or business looking to implement an electric LGV fleet of similar size. Due to the highly variable business models and technological approaches to implementing an electric LGV fleet these costs should only be considered representative of the 2017 Gnewt Cargo trial and not be used as guidance for extrapolation.

While the comparative assessment done throughout this work is based on a 3-year lease ownership model, which is typical for a freight fleet of this nature, there is also the potential to purchase electric LGV's outright as an initial capital expense. The approximate upfront cost of the EVs used in this study is £28,000. This is based on a £18,000 purchase of a traditional diesel LGV and a £10,000 electric conversion. These costs are highly variable based on a number of market conditions, particularly around the purchasing power of the business to purchase at scale, the ability to procure commercial EVs at scale and the fluctuation of exchange rates and associated import costs.

Summary of Findings & Next Steps

The Gnewt Cargo EV trial provides an insight into the practical performance and economic feasibility of the ongoing push toward cleaner and more efficient vehicle traffic in London. Given the Central Government's plan to cease the sale of conventionally powered vehicles by 2040 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.[31]

The Gnewt Cargo trial demonstrates electric LGVs have significantly lower operating costs than traditional vehicles – a diesel LGV is 45% or £0.43 more expensive to operate per km than an electric LGV. Beyond operating benefits, the socio-environmental benefits associated with electric LGVs replacing diesel equivalents provide a 2p benefit to Greater London per kilometre driven. Given the 2017 forecast of approximately 4 billion kilometres driven by LGVs in London[32], a number that has the potential to continue to rise over the next decade, it is easy to see the magnitude of the potential implications of transitioning the London LGV fleet from diesel to electric. For instance, a fully electric fleet in 2017 could potentially provide up to a £60 million benefit to the London environment, and a total cost reduction of £1.7 billion to LGV operators.

It is important to understand these conclusions are drawn from the Gnewt Cargo trial data which compared specific models of electric and diesel vehicles. Further exploration is required to understand the potential implications for London when incorporating a far broader range of data from LGVs of varying sizes and manufacturers. Furthermore, the conclusions drawn are based entirely on the driving patterns and operations of the Gnewt Cargo trial fleet and may change given variations in how LGVs are operated, the necessary range required, and the payload contained.

While this research adds value to understanding the various operational cost differences and environmental benefits associated with using electric LGVs, it would be beneficial to conduct further work on understanding the capital and infrastructure cost implications of transitioning to electric LGVs.

A follow-up report will be produced in 2019 to incorporate and further compare the variations between the existing trial fleet and the new EV types joining the Gnewt Cargo

[31] Department for Environment Food & Rural Affairs: UK plan for tackling roadside nitrogen dioxide concentrations 2017

[32] Based on continued growth in line with historical trend from 1997-2012 according to TFL London Freight Data

fleet in late 2018. The update will illustrate the potential variation in implications based on capacity and payload of varying sized EVs relative to their diesel fuelled counterparts.

Appendix A

Key Annualised Parameters

Annualized Parameters	Unit	Source	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Fuel Costs												
Diesel Fuel												
Full Cost	£/l	GOV.UK Fuel Cost Data Annual UK	1.12	1.15	1.17	1.20	1.22	1.25	1.27	1.30	1.33	1.35
VAT Portion (20%)	£/l	GOV.UK Fuel Cost Data Annual UK	0.22	0.23	0.23	0.24	0.24	0.25	0.25	0.26	0.27	0.27
Fuel Tax Portion	£/l	GOV.UK Fuel Cost Data Annual UK	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Electricity												
Electricity unit charge	£/kWh	Gnewt Cargo; Non-Domestic Energy Costs UK	0.11	0.12	0.12	0.13	0.14	0.14	0.15	0.16	0.16	0.17
Electricity standing charge	£	Gnewt Cargo	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Fuel Usage												
Diesel Fuel												
Change in Fuel Efficency Per Annum	%	DfT Tag Data Book A1.3.10		-0.06%	-0.40%	-1.33%	-1.39%	-1.30%	-1.20%	-1.13%	-1.05%	-1.01%
Fuel Efficency Annualized	L/km	Vehicle Certification Agency UK	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.09	0.09
Electricity												
Change in Fuel Efficency Per Annum		DfT Tag Data Book A1.3.10		-0.21%	-0.21%	-0.21%	-3.05%	-2.81%	-2.59%	-2.41%	-2.24%	0.00%
Fuel Efficency Annualized	kWh/km	Gnewt Cargo	0.26	0.26	0.26	0.26	0.25	0.25	0.24	0.23	0.23	0.23
Emissions												
Diesel Fuel												
Fuel Consumption to GHG Emissions	kgCO2e/l	DfT Tag Data Book A3.3	2.56	2.51	2.47	2.42	2.42	2.42	2.42	2.42	2.42	2.42
Electricity												
Electricity Consumption to GHG Emissions	kgCO2e/kWh	DfT Tag Data Book A3.3	0.32	0.31	0.30	0.28	0.27	0.26	0.25	0.23	0.22	0.20
Carbon price £/tCO2e (non-traded)	£/tCO2e	DfT Tag Data Book A3.4	64.66	65.63	66.61	67.61	68.74	69.87	70.99	72.12	73.25	74.37
Other Factors												
Noise Production Values	£/km	DfT Tag Data Book A5.4.2	0.0025	0.0025	0.0026	0.0026	0.0027	0.0027	0.0028	0.0029	0.0029	0.0030
Air Quality Values	£/km	DfT Tag Data Book A5.4.2	0.0014	0.0012	0.0011	0.0010	0.0009	0.0009	0.0009	0.0010	0.0010	0.0010
Vehicle kilometres												
Greater London - growth in LGV KMs per annum	%	TfL London Freight Data Report 2014	0.73%	0.73%	0.73%	0.73%	0.73%	0.73%	0.73%	0.73%	0.73%	0.73%
Greater London - LGV Vehicle KM Forecast	billion km	TfL London Freight Data Report 2014	3.98	4.01	4.04	4.07	4.10	4.13	4.16	4.19	4.22	4.25
Gnewt fleet - Average total distance	Km/week	Gnewt Cargo	6,955									
Week to year factor	weeks/year		52.14									
Gnewt fleet - Average total distance	km/year		362,620									

Appendix B

Gnewt Cargo Vehicle Matrix

		CURRENT ELECTRIC VEHICLES		TRIAL DIESEL VEHICLES	
	Vehicle Ref.	Renault Kangoo	Nissan eNV200	FIAT DUCATO	NISSAN NV200
Vehicle Info	Vehicle Picture				
Vehicle Category & Dimensions	Vehicle class	N1	N1	N1 Light commercial vehicle	N1 Light commercial vehicle
	Make	RENAULT KANGOO	NISSAN	FIAT DUCATO	NISSAN
	Model	Kangoo Z.E.	eNV200	Ducato 35 Multijet	NV 2000
	Vehicle Gross weight (kg)	2146kg	2220	3000 (kg)	2000 (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
	Overall vehicle dimensions - Length / width / height (mm)	4282, 2138, 1844	4560, 1755, 1858	4693 / 2050 / 2254	4400 / 1690 / 1860
	Cargo space dimensions - Length / width / height (mm)	1476, 1129, 1251	2040, 1500, 1358	2670 / 1870 / 2524	2040 / 4500 / 1360
	Payload volume (m3)	3.4	4.2	8.0	4.2
Supplier Information	OEM/Manufacturer and location	Maubeuge, France	Barcelona, Spain	Val di Sangro, Atessa, Italy	Barcelona, Spain
	Build time/Lead time for delivery	3-4 months	3-4 months	2 months	2 months
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
	First Year VED	£0	£0	£210	£295
	Lease cost	£240	£240	£230	£200
	Minimum lease term	3 years	3 years	3 years	3 years
	Itemise running costs	£480 (est)	£480 (est)	£2,880	£2,300
	Maintenance cost	£120	£120	£160	£160
	Tax band	E	A	K	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)
	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.
Engine & Transmission	Engine	Electric motor – Synchronous AC motor	EM57 - AC Synchronous	Euro 6	Euro 6
	Max Power bhp @ rpm (engine power kW)	44	80	Diesel, 130 @ 3600	Diesel, 90 @ 4000
	Cylinder Capacity	0	0	2287 cc	1461 cc
Transaction Battery & Charging	Type	Lithium-Nickel-Manganese-Cobalt (LiMiNmCoO)	Laminated lithium ion	N/A	N/A
	Weight (kg)	260	?		
	Capacity (kWh)	33	14		
	Charging time (hrs.)	9	7		

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.