Final Report : Multi-carrier consolidation - Central London trial

Multi-carrier central London micro-consolidation and final delivery via low carbon vehicles

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Greater London Authority
28 April 2017

Published by
Greater London Authority
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The Queen's Walk
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London SE1 2AA
www.london.gov.uk
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minicom 020 7983 4458
ISBN
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Executive Summary

Background

The Mayor's Smart London Demonstrator programme aims to bring together emerging concepts and opportunities in Smart and Sustainable Cities to demonstrate the economic, social and environmental value that can be created through the application of digital (data-driven) solutions. It also explores systemic approaches to city-wide infrastructure and services.

The Agile Urban Logistics project was delivered under the Mayor' Smart London Demonstrator programme. The aim was to trial innovative solutions for the light freight sector that allows it to adapt to changing regulatory and market conditions, mitigating congestion and emissions impacts.

In 2014, the GLA invited grant-funding proposals to deliver a "Multi-carrier central London micro-consolidation demonstrator with final delivery via low carbon vehicles ("Agile 1")." Following a competitive grant-funding round, Gnewt Cargo was awarded circa £288k funding from the GLA to run the demonstrator using a range of electric vehicles which started in October 2014 and ended in June 2015.

The project also assessed the potential for:
1) re-timing of e-commerce B2C activity, away from peak hours
2) re-routing of journeys away from the most congested roads and pollution hot spots
3) consolidation and a reduction in the number of pick-ups/drop-offs
4) utilisation of low emission vehicles
5) reduction in emissions (CO_2, diesel particulates, NO_X)

Gnewt Cargo Ltd.

As of June 2015, Gnewt Cargo is the single biggest operator of a 100% electric van fleet for urban freight in the world. It is a growing Logistics Service Provider running delivery operations with 100% full-electric vans and cycles in Central London and has been running since 2009. In the Agile Gnewt Cargo trial, the demonstrator carried parcels for final delivery in central London for several major parcels businesses (namely Hermes, TNT and DX, all of which are active in business-to-consumer (B2C), home deliveries, and business-to-business (B2B) operations in London and the UK). The area covered focuses around the London Congestion charge area with a keen focus on the west side of this highly polluted region.

The Project

The project consisted of three case studies and five more general studies. Each case and general study demonstrates how the project achieved its targets, and gives answer on what are the beneficial impacts for the environment, business efficiency and profitability.

This report presents the results of the implementation of the demonstrations to include:

- **Case Study 1:** Set-up and Run an Additional Depot, expanding the area of delivery to SW1. *Better understanding of the expansion of depot and electric vehicle operations into this new area*
- **Case Study 2**: Business Case of Running Operations from Multiple depot and operating from New Premises. It also evaluates how to manage a new depot and compares it/combines it with the management of the previous depots.

- **Case Study 3**: Testing the Fitness for Purpose of Different Electric Vehicles for Different Clients. Assessing the practicality of a range of types of vehicles - including, electric vans and e-cargo bikes.
- **Generic study 1**: Improved Design of Technology Tests. Find a solution for designing technology test and manage them efficiently
- **Generic study 2**: Improved Data Collection. Find a solution for data collection consistent with previous information systems in place.
- **Generic study 3**: B2C Improvement Find a solution for designing technology test and manage them efficiently
- **Generic study 4**: the testing of public access electric charging infrastructure
- **Generic study 5**: Cooperation Management. Improve the cooperation with existing and potential future partners of clean delivery business.

Targets achieved

Initial targets were set for achievements of the demonstration as a whole in 2014. These targets were mostly achieved by the end of the project in June 2015 and are presented and explained in detail in Case Study 2:

Table A: Key indicators, targets, achievements and proportion of targets achieved

	Before trial	Target for trial	Actual achieved in trial
Reduction in km travelled	100	31	48
Reduction in NO_x	100	29	19
Reduction in PM	100	13	19
Reduction in CO_2	100	33	12

Source: Agile demonstration 2015

Three additional Key Performance Indicators were achieved

- Reduction in the main axis distance: 74%
- Reduction in empty vehicle distance: 65%
- Increase in staff employed: 7%

The trial commenced in August 2014 and final data collection took place in June 2015. Very few theoretical assumptions were made. Data presented in this report is based on original company data which was used to do impact calculations. Great care was given to ensure that the business data was representative for the parcel services sector in general, and for other parcel transport businesses in London as a whole.

As far as possible assumptions were based on data collected about actual operations during the trial.

Results

For **Case Study 1**, the new depot operations were successfully set-up and run for the peak Christmas delivery period at the end of 2014. The new electric vehicles were successfully introduced into the operations. This Case Study has helped to demonstrate how to successfully open a new depot and operate an electric fleet in Central London, starting from an existing business. The solution is viable and scalable. The Case Study 1 resulted in a reduction of 20% vehicle kilometres.

For **Case Study 2**, the original demonstrator data was collected before and after the trial started, to allow robust quantitative results, and evidence is available, presented in this report, and analysed. Compared to the situation before the business with electric vehicles and depot operations commenced, *the total distance travelled, measured in kilometres per parcel, has been reduced by 52%*.

This reduction is a like for like comparison to the previous logistics service provider businesses operating directly to customers from depots in outer London. Other external impacts such as contributions to traffic congestion and accidents would therefore be expected to also be reduced, as a result of adopting such a logistics system, as the total distance travelled is an important indicator for these other negative externalities of freight transport.

On main axis roads between suburban areas and Central London, *the distance reduction was 87% in January 2015, and 78% in April-May 2015 periods*. Night-time operations have replaced peak-time morning operations on the congested main axis roads from suburban to Central London. As a result of the trial, there has been a 1*00% reduction of the part of the delivery trips occurring on main axis roads* during journeys between suburban depots and Gnewt micro-consolidation centres in London during peak morning traffic. This corresponds to a *reduction of between 35 and 50 diesel vans removed from these roads and at these busy times*.

Empty running distance has been reduced by 65%. Empty trips as such do not represent an issue in parcels services, and when analysing the situation before. *Air pollution*, measured for PM, NOx, and other pollutants, was *reduced by 81% and CO_2 by 88%* in the trial, due to the use of an electric fleet and strong reductions in distance travelled by diesel vehicles. The residual air pollution is due to the night trips of diesel trucks travelling from the suburban depots and unloading the parcels at the Gnewt Cargo depots in central London.

Case Study 3 demonstrated a good performance of Nissan eNV-200 and Renault Kangoo ZE, two of the many electric vans tested during the trials. It also demonstrates good results for using Fleetcarma and Emakers systems, two IT products assisting data collection and management of a clean vehicle fleet. *Vehicle energy prices were 87% less for electric vans than diesel vans*. During the period Jan to Jun 15, electricity price per van per month is about £9. For Generic Study 1, the main innovation was to apply a consistent before-after model for the design of the tests, that proven effective and that will be reused in future demonstrations and trial of new technologies or organisational measures.

For Generic Study 2, a new data collection system was added to the existing Gnewt Cargo information system, allowing for a clear coverage of all parts of the business activities and linking with the interests of the GLA Agile Urban Logistics programme. The data was collected successfully and is presented in this report.

For Generic Study 3, the IT solution tested improved the communication with the clients and this technology will be further expanded and tested in near future.

For Generic Study 4, the trial has not succeeded and the charging infrastructure was not available.

For Generic Study 5, the cooperation was based on individual contacts and worked very well. Gnewt intends to expand the cooperation with its partners. According to the Agile Urban Logistics programme objectives, this report shows, to the business community and public sector decision makers, the benefits that result from using clean vans and consolidation centres.

Legacy

As a legacy, the effects of introducing the solution on the market are clearly beneficial for wider society both for the environment and business efficiency and profitability. The data collected and analysed provides evidence that the operational solution trialled can be replicated, new Central London depots can be opened, and new clean freight vehicles can be purchased and used successfully in London.

In order to scale up the solution demonstrated in this project, several possibilities seem feasible. The first would be the economic growth of the current business through acquisition and contracting of new large-scale clients in London, the opening of new depots and the purchase of additional clean vehicles. The knowledge on how to do this is now available from this trial and is replicable.

The second solution would be to apply the same solution in another business such as food deliveries or construction. Ideally, the successful transfer of this solution from one business sector to another should be trialled and evaluated so that it can be robustly studied and the evidence and the knowledge about it become publicly available.

The third solution would be to transfer the solution to another area of London, to open a new depot there, to obtain a contract with a new client, and to purchase a clean vehicle fleet. Again this transfer of good practice would benefit from a trial phase and from a quantitative evaluation.
Gnewt's business model and infrastructure was tailored towards this type of operating model from the company's inception.

It is this fact that has enabled Gnewt to achieve the environmental savings and operational efficiency that has proved a barrier to other logistics companies. The concept of smaller, central consolidation centres and a fully 100% electric fleet is integral to the success of Gnewt and the ability to provide viable research results to GLA.

Constraints and challenges experienced during the project

Technical barriers

There are limitations to the approach trialled in this project and the ability to deliver the legacy above. The electric freight business is not currently suitable for heavy loads transported by Heavy Goods Vehicle. For pallets or heavy goods deliveries to receivers of more than one tonne per day, trials with other alternative fuels are likely to currently prove more successful such as the experience of Howard Tenens with biogas as fuel and gas motor as main engine. This has not been tested in London yet.

The 100% full-electric freight business is also not suitable for long distance transport and the current range of approximately 60 miles per day is fairly limited, but this is considered sufficient for parcels deliveries. Due to the range limitation, a high density of customers is required. A transport business that would require long distances between customers is not suitable for full-electric vans at this time.

Charging infrastructure

One test the project was unable to make any headway was about the London charging infrastructure. Of the approximate 1600 charge points in the Capital, Gnewt found that less than half of them were functional. Of the fast charging points that were/are of particular interest for fleet operators that need this capability to ensure the viability of electric vehicles, there were virtually none in operation within the Central London area.

Vehicle legislation

Some of the vehicles we hoped to test as part of this project were not made available for a live trial, due to the inability to get clarification on how they were to be classified. Vehicle variants, especially in the electric vehicle market, is getting ever more diverse, but current legislation sometimes struggles to categorise these alternative means of transportation which results in stemming the progress of these more environmentally led alternatives.

There is also out-dated legislation we discovered during this trial that is not fit for purpose. For example, commercial electric vans older than 3 years are exempt from MOT testing due to rules created around milk floats. Although the vehicles have considerably less mechanical parts and less wear and tear, fundamentals such as tyre and brake wear are equally prevalent but not compulsory to be checked.

Gnewt's thoughts and reflections

In our experience and from what we have learnt throughout this project, there are a number of areas whereby local or governmental policy changes would help drastically increase both the uptake in EVs but also allow a more viable scalability for companies such as Gnewt and the concepts that were analysed as part of this report.

Penalty Charge Notes (PCNs)

Parking tickets are a significant cost to businesses like Gnewt. In many cases, tickets are issued not because drivers have parked illegally, but simply because a rule is given to Parking Attendants that if no continuous activity is seen for a period of 5 minutes, then a ticket can be issued despite the driver not exceeding his 20 or 40 minute allowance. Drivers have reported that their productivity and efficiency would be greatly increased (and consequently result in considerably less journeys travelled) if they were not required to relocate their vehicle so many times a day just to avoid a ticket issue.

Gnewt's success rate on appealed tickets is currently over 90% demonstrating that many tickets have been unnecessarily issued at a cost both to the businesses and councils alike.
So there are two points that could be avoided through an improved PCN management in future:

- The impacts of the charges for business and councils should be reduced through changes in application rules
- The behaviour change of drivers would lead to an improved traffic and more delivery efficiency if exempted from the need to remove the vehicle to avoid PCNs.

Electric vehicle recharging

As previously mentioned, the London charging infrastructure, were it working to its fullest, would be a huge benefit to the uptake of EVs. Currently for companies like Gnewt, such is the uncertainty and unreliability of the network, and despite millions of miles travelled by EV in the last 5 years, not one Gnewt van has ever used the public charging infrastructure.

Central locations

In order for the operations demonstrated in the trial/case studies to work, central locations for logistics depots are vital. As the battery technology continues to improve, the need for the very central locations, that the likes of Gnewt utilises, will reduce, as the vans will be able to travel further. However, with all the new development now happening in the City and the wider London area, very little consideration has historically been placed on how these new office blocks and residential dwellings are to be serviced by the road network.

This project utilised in Case Study 1 a Crown Estate property that had under-utilised space to great effect and the big land owners in London will certainly have similar areas that could benefit from this alternative use. We believe that areas of new development should be safeguarded and incorporated in the planning to achieve the scalability and success that this project has demonstrated.

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1. Introduction

1.1 GLA Agile Urban Logistics

The Mayor's Smart London Demonstrator programme aims to bring together emerging concepts and opportunities in Smart and Sustainable Cities to demonstrate the economic, social and environmental value that can be created through the application of digital (data-driven) solutions. It also explores systemic approaches to city-wide infrastructure and services.

The Agile Urban Logistics project was delivered under the Mayor' Smart London Demonstrator programme. The aim was to trial innovative solutions for the light freight sector that allows it to adapt to changing regulatory and market conditions, mitigating congestion and emissions impacts. This is seen as important as light freight journeys are already responsible for 80% of freight mileage on London's roads; TfL projects that by 2030 this will grow by 43%. Congestion costs the economy an estimated £2 billion a year. Stationary traffic in London has been found to lead to 8% more CO_2, 6% more PM_{10} and up to 9% more NO_x emissions than free-flowing traffic.

The growth in e-commerce and personal deliveries is identified as a major contributor to this rate of increase. As such, light freight vehicles are a growing contributor to congestion. Congestion extends journey times, reduces business efficiency and contributes to poor air quality and carbon emissions.

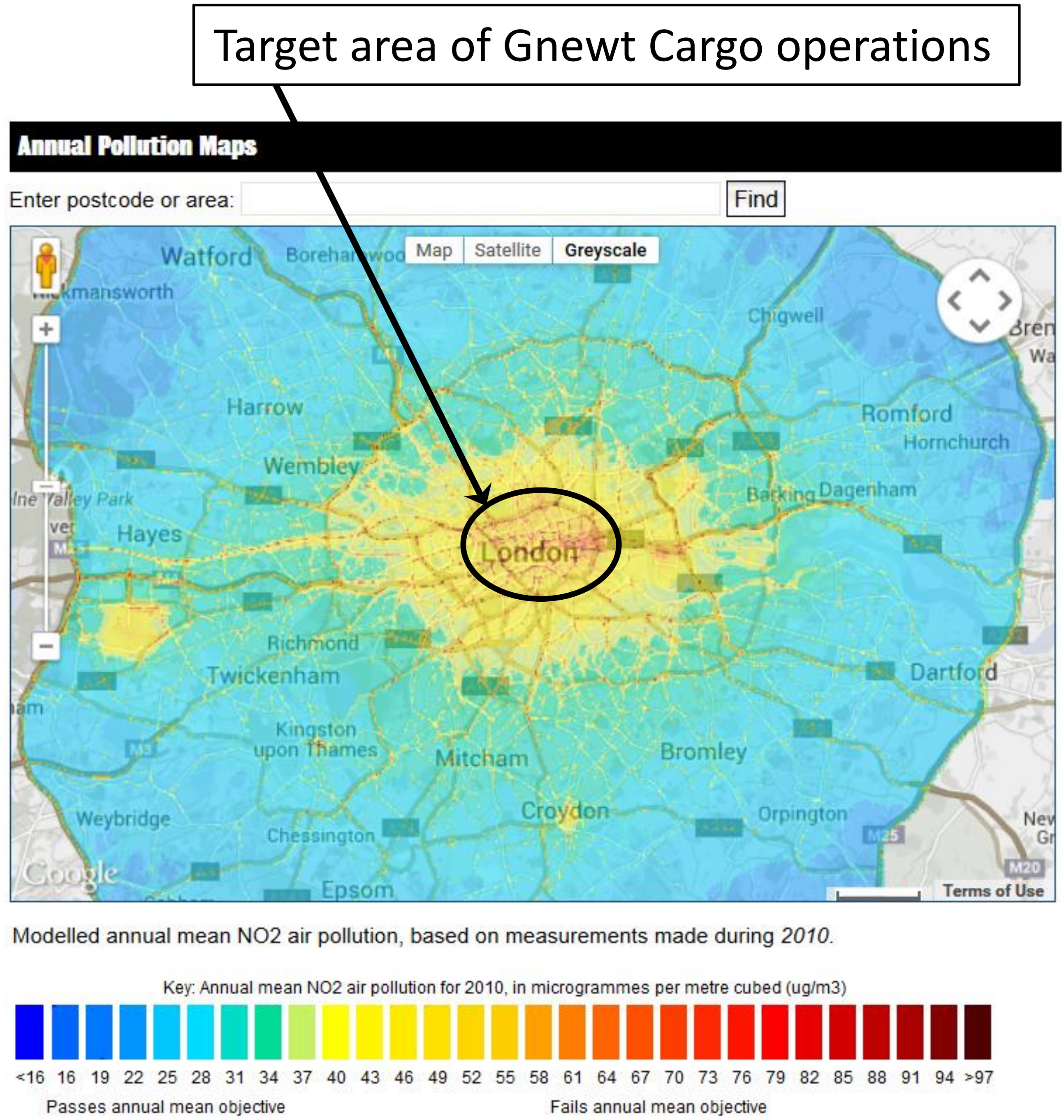
In 2014, the GLA invited grant-funding proposals to deliver a "Multi-carrier central London micro-consolidation demonstrator with final delivery via low carbon vehicles." Following a competitive grant-funding round, Gnewt Cargo was awarded £288k funding from the GLA to run the demonstrator using a range of electric vehicles which started in October 2014 and ended in June 2015.

The project also assessed the potential for:

6) re-timing of e-commerce B2C activity, away from peak hours
7) re-routing of journeys away from the most congested roads and pollution hot spots
8) consolidation and a reduction in the number of pick-ups/drop-offs
9) utilisation of low emission vehicles
10) reduction in emissions (CO_2, diesel particulates, NO_X)

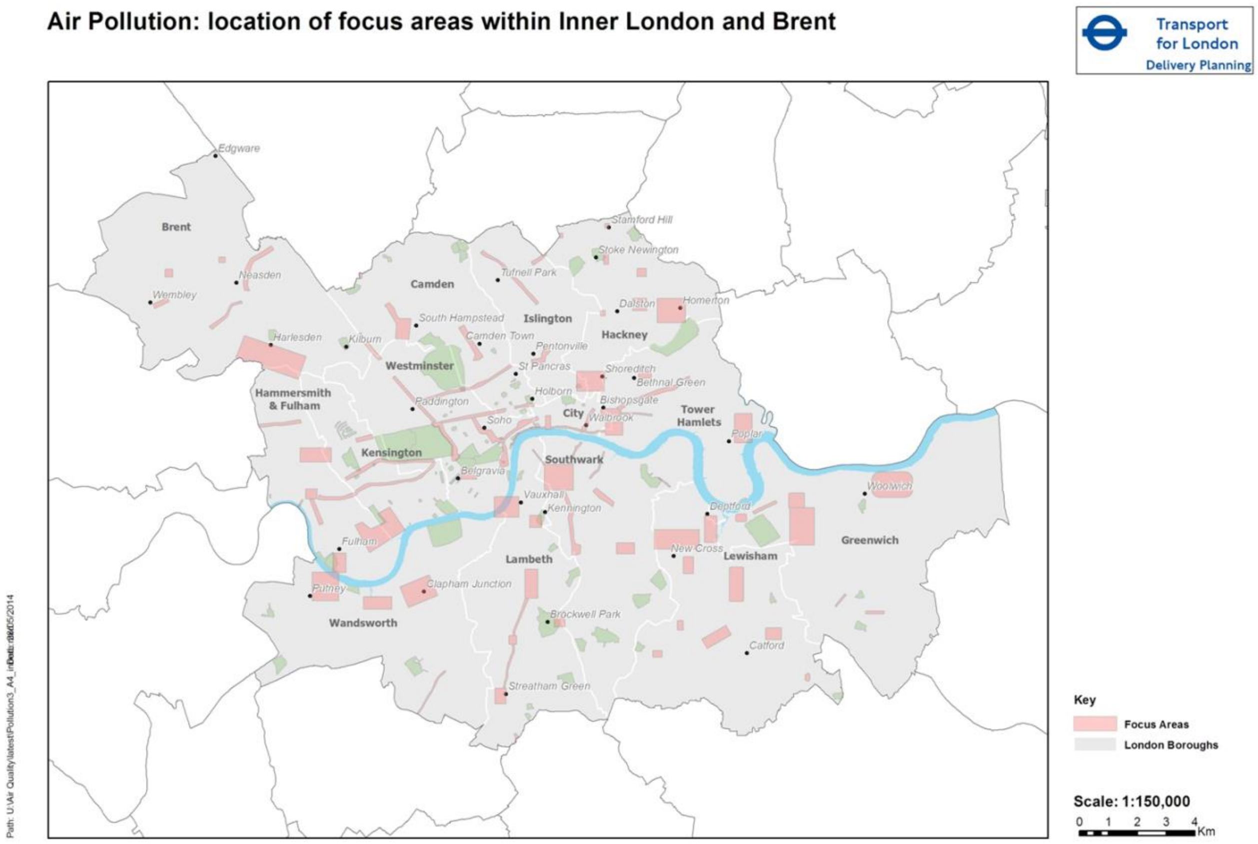
The area of the Agile Urban Logistics project corresponds to the area of London areas identified in following maps. Figure 1 shows air pollution in London, and indicates that the central and inner London area is more strongly impacted than the suburban areas. The centre of London is therefore a target area for policies aiming at a better air quality. Figure 2 shows the location of the target area for the GLA Smart Cities demonstrations.

Figure 1: NO_2 air pollution distribution in London 2010, and targeted area of operation



Source: Londonair : Annual Pollution Maps http://www.londonair.org.uk

Figure 2: Focus areas in London targeted by the GLA demonstration programme



Source: The Greater London Authority (GLA) 2015

In this context, GLA has funded demonstration projects to show to the business community and public sector decision makers the benefits that result from using clean vans and consolidation centres. The so-called Category 1 demonstrators in Agile Urban Logistics were defined as: "Multi-carrier central London micro-consolidation and final delivery via low carbon vehicles."

The Agile Gnewt Cargo demonstration reported on this document is defined as a Category 1 demonstrator in the GLA agile Urban Logistics programme.

1.2 Background information about Gnewt Cargo

The Agile Gnewt Cargo demonstration project is a GLA funded project about multi-carrier deliveries in central London using micro-consolidation centres and electric vehicles for final delivery. The project started in October 2014 and ended in June 2015.

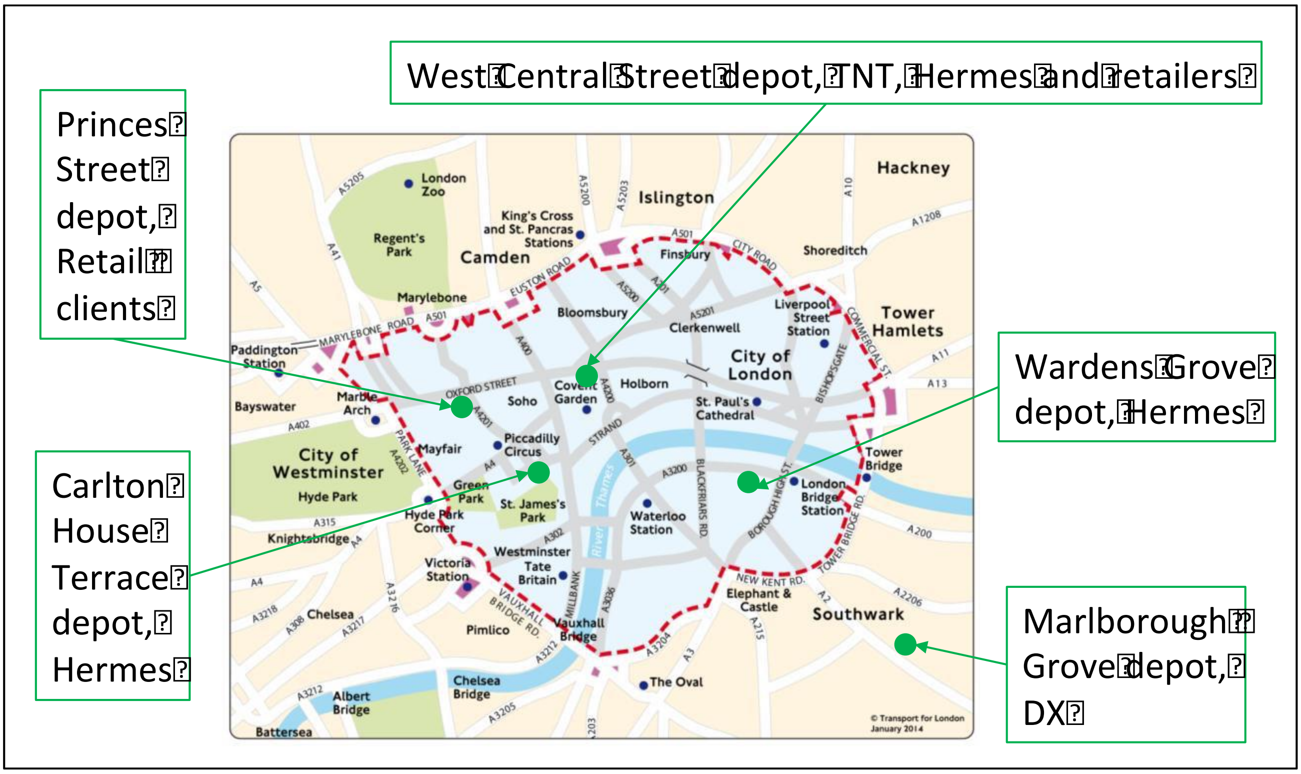
Gnewt Cargo is the single biggest operator of a 100% electric van fleet for urban freight in the world (as at June 2015). It is a growing Logistics Service Provider running delivery operations with electric vans and cycles in Central London. Gnewt Cargo is a so-called carrier's carrier making final deliveries on behalf of other carriers including Hermes and TNT. Gnewt Cargo has grown in 5 years from running clean operations for a single client using 9 vehicles and one depot to running operations for multiple clients with a fleet of approximately 100 electric vehicles using 5 depots in Central London.[1]

One of these depots, opened in Spring 2014, is located in Southwark on Wardens Grove near Great Guilford Street, servicing the client Hermes, a large parcel service and e-commerce specialist in business-to-consumer (B2C) and home deliveries activities. A second central depot is located in West Central Street near New Oxford Street, serving mainly TNT, one of the world leading parcel service company, mainly active in B2B, but also with a growing tendency in home deliveries. The third, smaller depot, is located on Princes Street near Regent Street, servicing a retail client. The fourth depot was opened in October 2014 in Carlton House Terrace, in the West End, and closed again in January 2015, with an option to reopen it in Autumn 2015 for the peak business time. This depot serviced Hermes.

The DX depot (the fifth depot) is located in Marlborough Grove and used by Gnewt Cargo for overnight base and transhipment for the DX parcels logistics services. The business of DX is also representative for many other businesses specialised in B2B and B2C trade in London. The 5 depot locations are shown in Figure 3.

Currently the Gnewt Cargo delivery area is almost identical with the Congestion Charge Zone in London (see Figure 3). A small number of other delivery areas, where Gnewt Cargo is making deliveries, are located just outside the Central London Congestion Charge zone: to the West (Pimlico), and to the South-East.

Figure 3: Gnewt Cargo delivery area in the Central London Congestion Charge Zone (red line), and location of depots



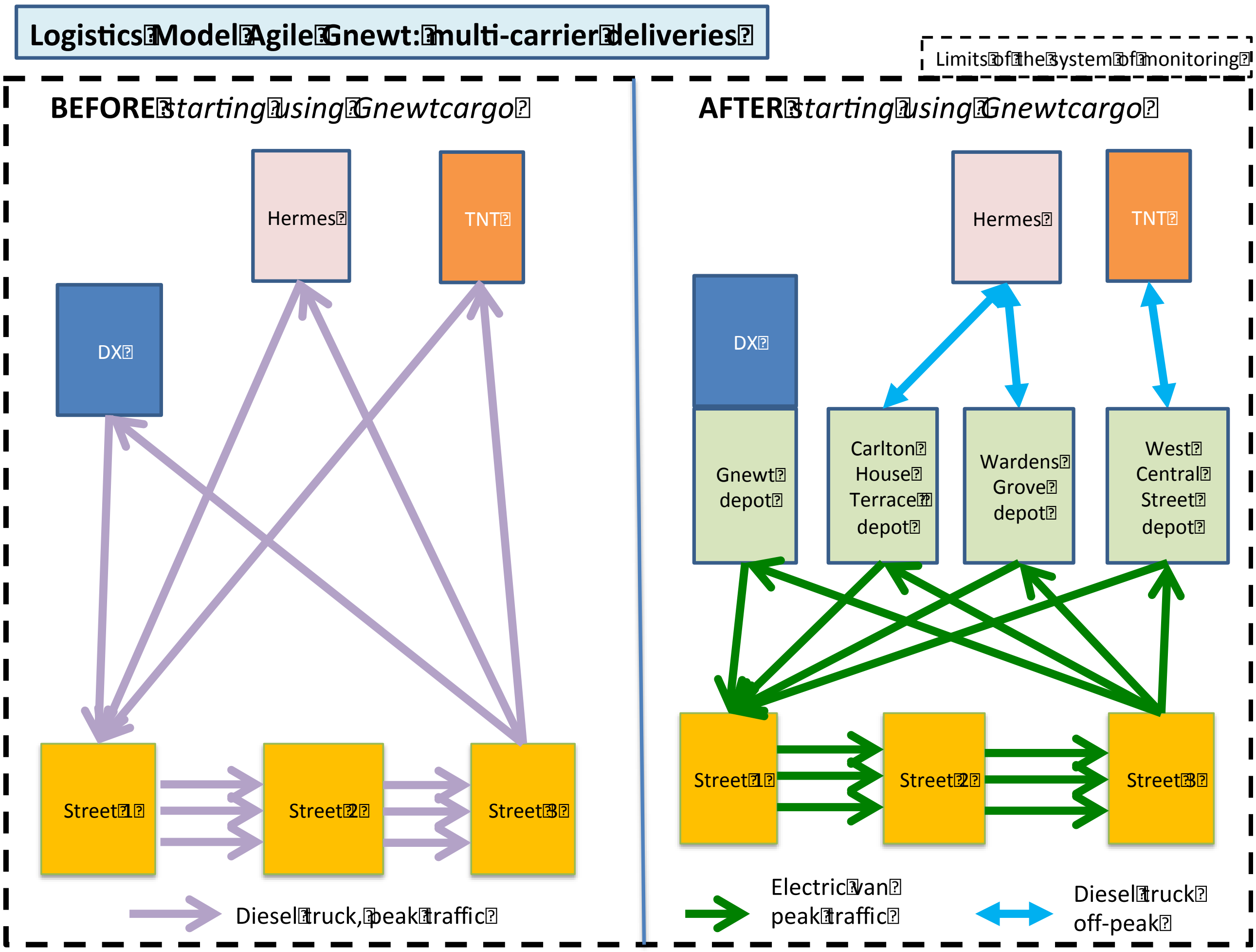
Source: TfL 2015, Agile Gnewt Cargo demonstration 2014-2015

[1] Logistics depots of Gnewt Cargo are so-called 'micro-consolidation centres', because these logistics facilities are used for transshipment of parcels and for parking and recharging of the electric vans overnight. In this report, the terms depots and micro-consolidation centres are used as synonym.

Figure 4 presents the logistics system that Gnewt Cargo is now part of. It compares the 'before' situation (i.e. before Gnewt Cargo was involved) and the 'after' situation (i.e. since Gnewt has become involved) for deliveries in central London of goods handled by Hermes, TNT and DX. The left-hand side ('before') shows the clients (Hermes, TNT and DX) performing their deliveries themselves or with the help of their subcontractors, starting from the suburban areas of London and using exclusively diesel vehicles for the final delivery trips in Central London, during peak traffic.

The right-hand side ('after' the involvement of Gnewt Cargo) shows the trips from the suburban depots of the clients are now transported to the Gnewt Cargo micro-consolidation centres in Central London, performed by diesel trucks in off-peak times. It shows also the final delivery trips performed by electric vans during peak traffic in Central London. 4 This model and its implications are explained in more detail in Case Study 2 (see Section 3.2).

Figure 4: Before-After Logistics Model of the Gnewt Agile demonstration with multi carrier deliveries



Source: Agile Gnewt Cargo demonstration 2014-2015

1.3 Objectives of the Agile Gnewt Cargo project

The main objective of the project is to provide quantified evidence on the benefits for the public sector and business profitability of deliveries using the Gnewt Cargo logistics system, which has been implemented using electric vans and multiple depots for final-mile delivery in Central London.

One of the "Agile Gnewt Cargo demonstrator" sub-objectives was to expand the operations of electric vehicles into West Central London, and to provide insight on this expansion from the point of view of a 'multi-carrier' and sub-contractor of large retailers and logistics service providers. Gnewt Cargo opened another depot and extended the delivery area covered to include the West of Central London, and can thus demonstrate how the opening and closing of a new depot can lead to the most efficient reduction in freight traffic and distance driven in Central London, mastering the annual fluctuations in logistics demand.

Another managerial objective was to better understand the management of multiple depots and the running of more electric freight vehicles for deliveries in Central London, for multiple clients.
Another sub-objective was to examine how Gnewt Cargo can improve both the environmental aspects of delivering in this area as well as look at ways of reducing the number of miles travelled per parcel, reduction in kerbside space usage, reduction in CO_2 emissions and noise pollution versus the diesel alternative and prove the validity of a micro-consolidation project in another area of London.

The starting point of the study was the decision by the GLA to demonstrate the benefits of the new urban delivery system based on consolidation in Central London and electric vehicles deliveries, and of Gnewt Cargo to assess its operations, aimed at demonstrating how it achieves the initial targets set by the GLA to reduce distance, empty running, air pollutant emissions and climate impacts.
The main elements of the project are three case studies.

Box 1: Case Studies and main questions to be answered

- Case Study 1: Set-up and Run an Additional Depot, expanding the area of delivery to SW1. *Better understanding of the expansion of depot and electric vehicle operations into this new area*
- Case Study 2: Business Case of Running Operations from Multiple and a New Premises. *How to manage a new depot, and to compare it/combine it best with the management of the previous depots*
- Case Study 3: Testing the Fitness for Purpose of Different Electric Vehicles for Different Clients. *Assessing the practicality of main types of vehicles, electric vans and e-cargo bikes for different businesses*

Gnewt Cargo previously successfully operated a micro-consolidation operation on Regents Street and the opportunity to set-up and run a new consolidation centre at Carlton House Terrace (case study 1) enabled Gnewt Cargo to extend the learning of that trial by testing different goods vehicles to deliver the same parcels. The objective of the trial with the Carlton House depot is also to prove the scalability of these projects and to encourage other large property owners to allow under-utilised central space to be better used to improve the environmental situation in the local area.

There were two reasons a case study with a bottom-up approach of business data collection was selected. Firstly, this is the current state of the art in urban freight science and academia, with a lot of previous knowledge available, a very proof secured way of obtaining robust results. The second reason is that every market player is familiar with the approach of copying good practices and therefore another sub-objective of this report is to document good business solutions and to make them easy to understand so that they can be replicated elsewhere.

The first step in the project was the initial preparation stage, achieved by mid-November 2014. The second intermediate step was focused on the first trial stages, followed by the completion stage of the trials. The trials started at the end of 2014 and continued until June 2015, when the reporting took place.

By June 2015 the trial stage was fully completed for all parts of the project. This completion of the trial has been made possible because notably the data collection of the new vehicles and the depot has been running well. This data allowed the development of a full analysis of the new vehicles and the depot solutions. The data collected has enabled the presentation of an assessment of the success of the trials and responses to the original demonstration questions in this report.

The main elements of the demonstration are the new depot, the use of electric vehicles, the use of electric energy, the parcels delivery performance, the depot management, and the beneficial impacts.
The ultimate objective of the Agile Urban Logistics programme is to achieve and secure longer term quantitative reduction targets, to better understand these specific questions of the clean delivery business, and therefore to enable future growth for this type of activity.

Main question is to estimate how this project is contributing to the London wide objectives of reducing emissions and congestions, as part of the GLA programme and to the other policies and programme such as Smart Cities.

The new depot is a so-called Micro Consolidation Centre, using Crown Estate premises. The demonstrator is testing different freight delivery vehicles starting from the fleet of existing electric vehicles. The objective of these vehicle trials is to assess validity and practicality of their usage, efficiency and growth potential for delivering last mile services in Central London, specifically the Congestion Charge zone.

2. Methods & Phases

2.1 Three Phases for the Trials

Three specific case studies were run during the trial phase. Explanations and findings of these three case studies (which were run as innovative trials) can be found in section 3. Each of these three case studies comprised three main phases:

1. Preparation phase: Validation, confirmation of the set-up and fine tuning of the operations and data collection efforts
2. Trial phase: Running the operations from the new depot and collecting the data on all depots and all operations in a consistent way in order to allow robust before-after comparisons of the effects of the innovations.
3. Data processing and reporting phase: After the end of the data collection, the project focused on data processing, analysis and reporting.

2.2 Data Capture

During each Case Study trial period a number of variables were measured and data was collected on:

- Vehicle movement reductions, in miles and % reduction
- Reduction in miles travelled per parcel
- Time vehicles spent on the road
- CO_2 and NO_x reductions relative to a diesel van delivering the same freight in the same area
- Efficiencies of varying types of electric vehicle
- Noise reduction
- Business case and KPI data such as:
  - costs of vehicle purchase and/or leasing
  - variable running costs per parcel or per stop for different clients, different area and different depots
  - fixed and variable depot management costs, depot rental
  - other fixed and variable costs
- Disruptions and risks for electric vehicle fleet operations

The data were collected throughout the entire demonstration project. Depending on the question, a different time period was observed. Some data are for one day, other for two weeks, two months or one year. This will be explained in detail below.

This final report (M8) focuses on the presentation of the analysis of the results. The full record of data collected in the trials is presented in the tabular form with short explanations in Monitoring Report M7.

3. Case Studies

3.1 Case study 1: Set-up of a new consolidation centre

Introduction to the Case

The Consolidation Centre set up as part of Case Study 1 was located on Carlton House Terrace, London SW1. The location is shown in Figure 3.

The purpose of this case study trial was to:

- Understand how to better manage the set-up of a new consolidation centre with clean vehicles, in order to secure long term growth.
- Demonstrate a good practice in expanding city centre delivery operations into a new area using a micro-consolidation centre approach
- Expand the delivery area covered by Gnewt Cargo towards the West of Central London, while at the same time better understanding the management of multiple depots and the operating of an increased number of electric freight vehicles for deliveries in all of Central London, for a single client.

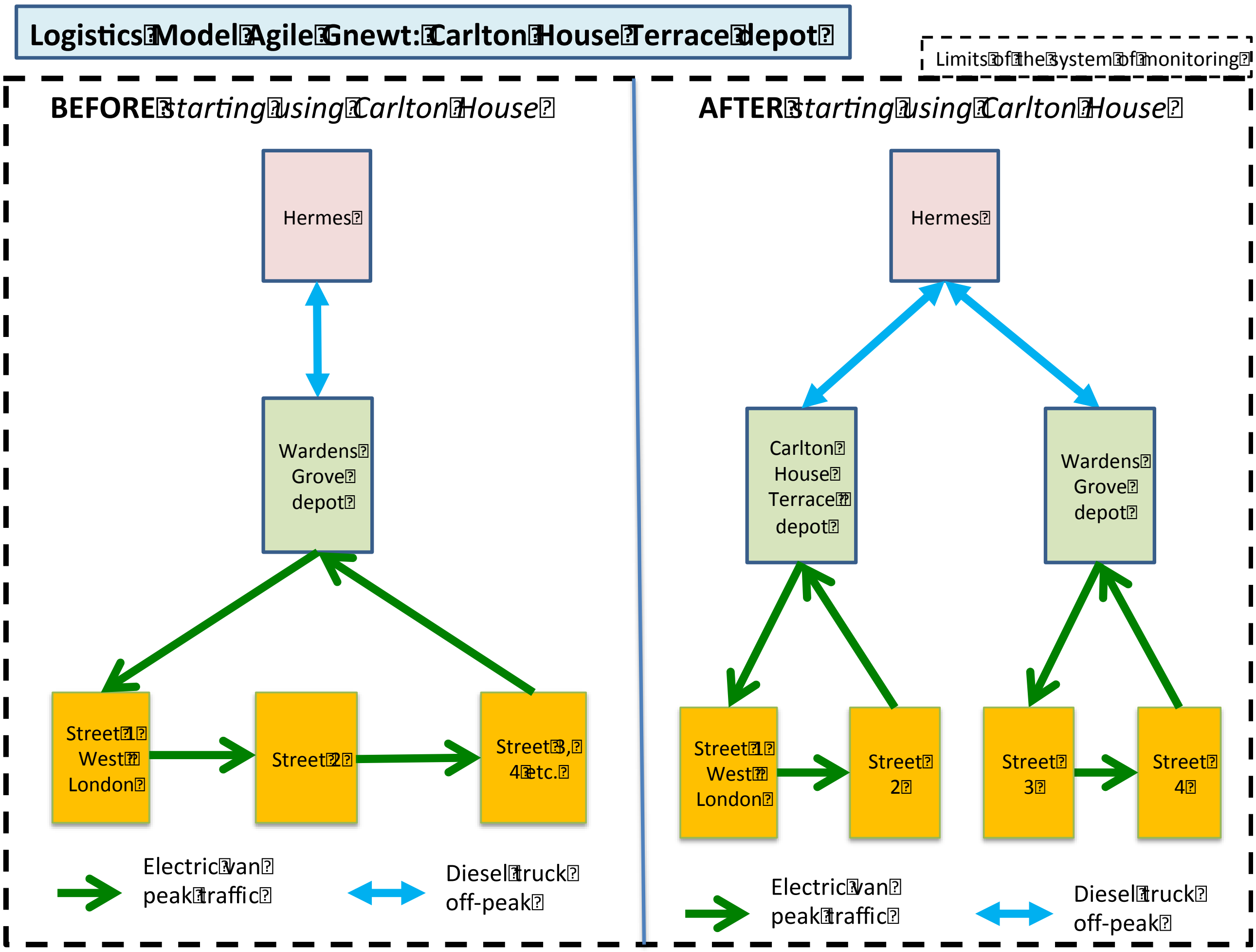
The owner of the depot space, the Crown Estate, allowed the logistics operations to commence in October 2014. The conditions of the rental of the space were secured in a written agreement (a so called "Licence to occupy").

A short period was needed for installation of necessary equipment. The first element to be installed was the power supply for the battery charging. The second element was the installation of transhipment devices, container boxes for the parcels transhipment. A small office was made operational to deal with all documentation, when the fleet started operations.

Once the space was ready, the first operations were conducted. The area served from this depot was in the West of the City of Westminster, in the SW1 area. The only client was Hermes, because at this start up stage a mix of load coming from different clients would have been too difficult to organise. Previously, the Hermes operations for this area were starting from the Wardens Grove depot. After the start of this trial, instead of going to Wardens Grove to unload the parcels at night, the Hermes trucks would go directly to Carlton House Terrace. The fleet of electric vehicles in use at the new depot mainly consisted of previously owned and newly purchased Renault Kangoo ZE vans.

Key data for the analysis is the location, surface and running costs of the new depot. This data was uploaded and recorded into the central Gnewt Cargo information system. The logistics model observed for the data collection is shown in Figure 5.

Figure 5: Logistics model before and after using the Carlton House depot



Source: Agile Gnewt Cargo demonstration 2014-2015

The preliminary results of the data collection of Case Study 1 are made available in the form of Tables in the Monitoring report M7. According to this data, the average mileage of the vans was 59 miles per week, about 12 miles per vehicle per working day. This distance of 12 miles per van per day is slightly shorter, but in a similar range like the distances observed at the two other depots of Gnewt Cargo. This average was measured during one week of data collection in October 2014.The average energy use by the van fleet at Carlton House Terrace was 3.6 miles per kWh. The energy price is £0.10 / kWh.

In order to estimate the importance of energy use and the energy price of the operations at the new depot, the data was compared for electric and diesel vans. A similar conventional vehicle is a Renault Kangoo diesel van. Its fuel use in urban delivery is estimated at 10l/100km. This estimate is taken from actual business data collected by the University of Westminster in Case Studies of other European projects BESTFACT and SMARTFUSION, run in 2014 and 2015 (www.bestfact.net; www.smartfusion.eu). This data is used for comparison purpose in the energy use analysis.
Table 1 shows the result of the first energy analysis for the new depot. The data was collected in the first week of 2015.

Table 1: Energy price and energy efficiency analysis per van at Carlton House Terrace depot, Jan 2015

	l/100 km	Distance mi/day	Distance km/day	Diesel price £ per litre	Diesel fuel used l/day	kWh/mile	Elec. price £/kWh	Diesel price £/day
Diesel van	10	12.0	19.3	1.3	1.93			2.51
Electric van		12.0	19.3			0.278	0.1	0.33

Source: Agile demonstration original data collection, January 2015

Compared to a diesel van, there is a factor of 1:7 for energy price in favour of the electric van i.e. the energy price for electric vans is 87% less than for diesel vans. The price of £0.33/day for electricity per vehicle is negligible compared with the costs of space rental, staff employed, vehicle purchase and other fixed logistics cost such as insurance, maintenance, etc. A full breakdown of all fixed and variable costs categories for all clients and all operations cannot be provided for confidentiality reasons. However, in the impact analysis of Section 3.2, further cost information is provided.

On the number of parcels delivered per round, the amount of Carlton House Terrace depot operation is similar to the other depots. Therefore, this performance in achieving the same logistics demand demonstrates that the functionality in opening a new depot can be attained very quickly, with the drivers being able to deliver the same number of parcels per day than they would have previously done when operating from the Wardens Grove depot. From the point of view of logistics depot management and micro-consolidation operation efficiency, the main advantage of running the operations at the new depot at Carlton House Terrace was the ability to store and tranship a large amount of additional parcels during the peak delivery time at the end of the year 2014.

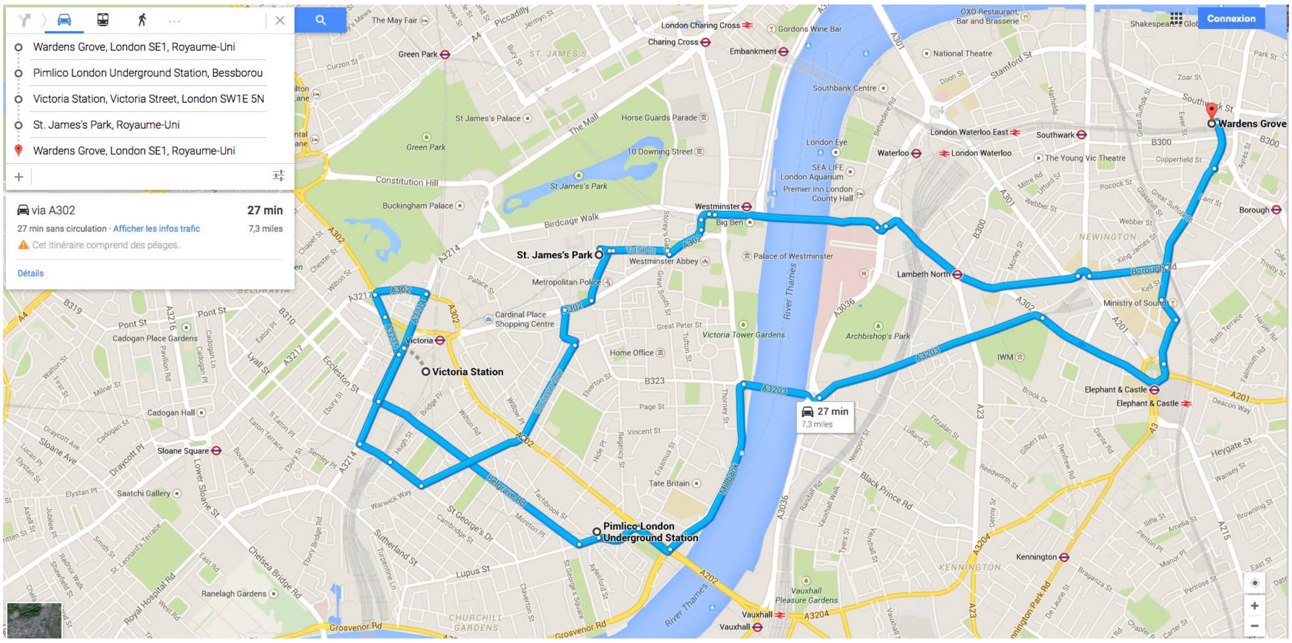
The logistics model was identical and reproduced as for the other four Gnewt depots, with trucks bringing all parcels for the day to the depot every night. The drivers sorted the parcels according to the final delivery area, and loaded the vans in accordance with the successive stops of each round.
The only logistical innovation was to make use of another additional depot, which would only have as a negative point the use and the price of additional space. After the big demand of the end of the year diminished strongly, there was no further need for this additional space, so the use of this additional depot was ended in January 2015.

3.1.2 Impacts of the new depot on delivery rounds

The impact on the distance of the delivery trips starting from the Carlton House depot location was analysed. During the testing of the depot, the GPS data recorded did not allow for an exact reproduction of the trips, because many parts of the round were missing in the map recorded by the GPS on-board devices.

So, to analyse the trips, we consider here a typical round trip as reported by the driver and the vehicle journey documentation of the main delivery addresses in the area of Pimlico and Victoria (Figure 6a). Compared are two trips, each starting and ending at a different Gnewt depot.

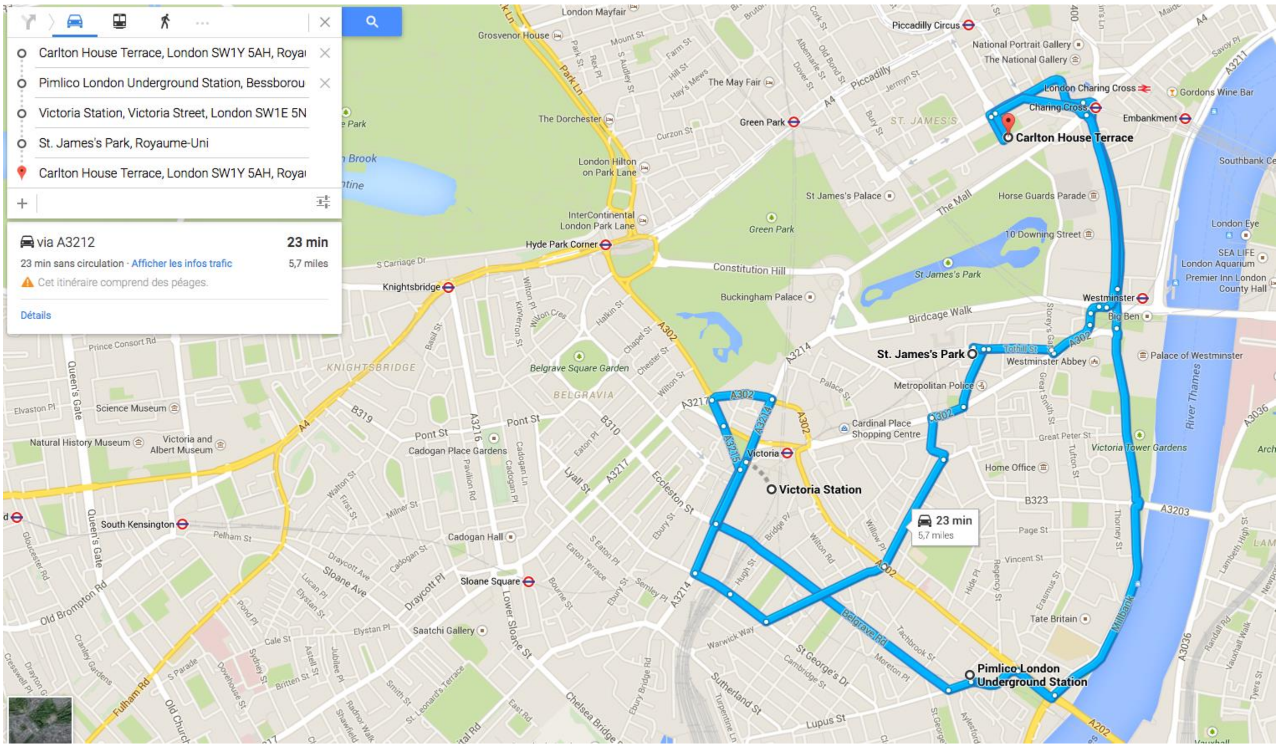
Figure 6a: Before: Round to the Pimlico and Victoria area, starting from Wardens Grove



Source: Agile Gnewt Cargo demonstration 2014-2015

This round was starting and ending at Wardens Grove, with 3 main stops at Pimlico, Victoria and St James's Park, and had a total mileage of 7.3 miles. This same round, when starting at Carlton House Terrace, had a distance of 5.7 miles, a reduction of 1.6 miles ('After', Figure 6b). Thus there was approximately a 20% reduction in the distance travelled per parcel, for those deliveries that are made in this area, when starting from the Carlton House Terrace depot, as compared to starting from the Wardens Grove depot.

Figure 6b: After: Round to the same Pimlico and Victoria delivery area, starting from Carlton House Terrace.



Source: Agile Gnewt Cargo demonstration 2014-2015

3.1.3 The lessons learnt from Case Study 1:

It is feasible to open and close again, a temporary new depot in a high demand area in case of demand peak. The new management knowledge and the additional high quality data on 'how to' open a new depot are essential for the future growth of this type of electric parcels delivery. This knowledge will be used for future business case preparations and future contracts.

The main operative advantage is the additional available depot space for the huge demand peak at Christmas time, with up to 10,000 parcels more per day to be delivered, on top of the existing business. The 1000 ft^2 available was used to sort parcels and to park the vans and recharge the batteries overnight.
It is not necessary to pay the high rental price of this additional depot for the whole year when it is not needed.

The current business contact, managing the facility at Carlton House Terrace, will allow the reopening of this centre for a short period at the end of 2015. This condition is, nevertheless, at risk of being cancelled anytime, which is one of the weaknesses of the solution. The advantages given by the close proximity to the delivery locations resulted in lower costs of transport operation, mainly the distance reduction leads to less driver time and increases the productivity so that more parcels can be delivered during a working day. About 20% of total distance and half an hour per day of driving time are estimated to have been saved for each van.

3.2 Case study 2: Before-After assessment of operations of many consolidation centres run in parallel

The purpose of this case study trial was to:

- Better understand how to manage multiple depots run in parallel in Central London
- Quantify the impacts of the Gnewt Cargo business when comparing the situation before and after the demonstration started
  - On Key Performance Indicators
  - On overall project targets
  - On additional indicators relevant for business and public sector
- Derive recommendations on depot management in Central London

3.2.1 Main effects of multiple depot management at Gnewt Cargo

The map in Figure 3 indicates the location of the 3 main depots of Gnewt Cargo that are under observation in Case Study 2. The two main consolidation centres of Gnewt Cargo are located in Southwark, Wardens Grove (25,000 ft^2) and near New Oxford Street in West Central Street (10,000 ft^2). Carlton House Terrace depot is smaller with 1000 ft^2. The DX depot is shared-used and only a small part is used for the Gnewt Cargo fleet and transhipment operations. The surface used is estimated to be less than 1000 ft^2. Another shared-used depot is located Princes Street. The surface used by Gnewt Cargo for one electric van and transhipment operations there is estimated to be less than 500 ft^2.

The freight transport operations of Gnewt Cargo are in large parts organised as a so-called "multi-carrier" delivery system. Figure 4 illustrates the logistics processes observed. As explained in detail in the data and monitoring report M7, the approach used in the Case Studies 2 calculation is to compare the logistics business situation before and after introducing the Gnewt Cargo Agile operations. The "Before" situation is shown on the left of the graph in Figure 4. The situation

"After" is shown on the right part. In the "Before" situation, the three clients Hermes, TNT and DX were running their operations with diesel vehicles starting in the morning from suburban depots, delivering all day in the city centre, and driving back empty to the depot in the afternoon. The deliveries were performed with traditional diesel trucks and vans.

In the "After" situation, the three depots of the clients are still part of the logistics system, but the trucks are only driving at night towards the city centre to unload the parcels at the Gnewt depots. The DX depot in Marlborough Grove is located close enough to the city, so it serves as an additional Gnewt depot and the Gnewt electric vans stay at DX overnight. This depot is used by Gnewt Cargo, but it is mainly run by the company DX for all its London operations. This depot is not managed by Gnewt Cargo, so it will not be in the focus of this study. This DX depot is unchanged before and after so there is little to say about differences in logistics except that the deliveries to Central London are performed via electric vans now.

At the DX depot, the parcels are not transferred to the other Gnewt Cargo depots, so there are no truck operations at night, like in the businesses of Hermes or TNT. The effect of DX using Gnewt Cargo for its London operations is a 100% substitution from diesel transport to electric transport, and a 100% CO_2 and emission reduction at tailpipe, when the before and after situations are compared on a like for like basis. However, because the DX operation only involved between 5 and 8 vans per day in total during the Agile Category 1 project period, this activity is not deemed representative for the whole of Gnewt Cargo operations. It was not counted when assessing the impacts. For the total distance, however, one limitation of this DX logistics system was that no reduction could be observed, as it was not possible to obtain data on the operations in the before situation of the DX depot.

As can be seen in Figure 4, the logistics system in the "After" situation is a bit more complex than in the original starting phase of Gnewt Cargo, where only one single depot was in use for one company. This complexity requires additional staff, new management tasks and IT tools to deal with the increased number of processes and the far higher amount of deliveries. In order to obtain the relevant comparative data, a sample of vehicles running from the different depots was monitored and their data was collected. A set of key facts and average values for each depot was compiled.

Additional to the data of these 3 Gnewt Cargo depots, data on the depots of the contractors (Hermes and TNT) were also collected. All the data mentioned in Section 2.2 were collected for each depot, including business costs data and external costs and impact data. The data collection was conducted according to the project plan presented and agreed with the GLA and presented in Section 2.

General data about Gnewt Cargo Agile demonstration

The general data represents detailed original qualitative and quantitative business raw data. This data was observed and collected through interviews with managers and drivers for the period August 2014 to June 2015 (Table 2). This data is both quantitative and qualitative and gives further insight into the business. It explains with more in-depth information the details of the logistics business model presented in Figure 4.

Table 2: General data and information on the "after" situation, observed between August 2014 and June 2015

Load, type of goods	On arrival at Gnewt Cargo: parcels in roll-cages, sacks, pallets. Yellow bins were used as temporary depot storage places in Winter 2014 and removed in Spring 2015, replaced by roll-cages for parcel delivery to the depots. Parcels; average weight of one parcel is between 0.5 and 10 kg, average size of 100-300 boxes fits within vans of 4 m3. The average volume is about 0.03 m3 per parcel. On arrival, parcels are already sorted according to round and delivery postcode area
Depots for Hermes / TNT/ DX / retail distribution operations	The warehouses of the 3 main clients Hermes, TNT and DX are Regional Distribution Centres for London and surroundings. Gnewt Cargo is running delivery operations starting from its depots: West Central Street depot: 10,000ft2 Wardens Grove depot: 25,000 ft2 DX depot by Old Street in London, 1000 ft2 Carlton House Terrace in West End: 1000 ft2 Princes Street near Regent Street: <500 ft2 Main functions of the depots are 'cross-docking' operations (consisting in receiving the goods in the night, unloading, sorting, loading the electric vans and distribute these goods on the same day). Another main task is the recharging of plug-in batteries of the parking vans overnight. One organisational task that is already performed by most clients is to prepare the sequence of orders to be delivered on the day's round trips.
Business	Starting from August 2014, between about 6-7000 parcels/day were delivered in normal times. During Christmas peak time, a period starting in September 2014 and ending in early January 2015, the day to day business consisted in up to 17-18,000 parcel deliveries per day. The area served is the Central London Congestion Charge area. The type of business is B2C and B2B; there are both business and residential customers in this area of London. Each driver has a dense area to serve in Central London.
Area of delivery and traffic	EC, SW, WC, SE postcodes in the central Boroughs of London. Mix of very busy narrow roads or, if wide road, no stopping (double red) lines and heavy traffic in the morning peak hours, and quiet residential streets. Visual observation in the morning traffic: between a third and a half of the traffic consists of vans of various size and small trucks, the other half being cars.
Vehicle fleet	Christmas peak (Aug to Dec fleet data): Up to 100 electric vans in daily use. Spring data about the fleet at Gnewt Cargo: 61 electric vans and one cycle in daily use.
Drivers	Between 53 and 110 drivers were employed in that period, covering the London delivery area.
Goods arrival	Depending on the total volume of the day, 6-7 Hermes trucks, DAF FT45, deliver at night to the Wardens Grove depot. 2 TNT trucks deliver at night to the West Central Street depot. DX depot is a warehouse where the goods are sorted and rounds prepared. Carlton House Terrace depot is a small parking area dedicated to Hermes, where one or two Hermes trucks delivered at night in the period October 2014-January 2015.
Loading	Takes place during the morning, starting at 07:00 a.m., all vans are loaded by Gnewt Cargo driver staff. Vehicle loading time is, on average, 45-60 minutes per van. The drivers arrive at depot around 07:00-08:00.
Collection	The collection consists of return loads (broken, not needed, etc). Between 0 and max 5 items collected per driver per day

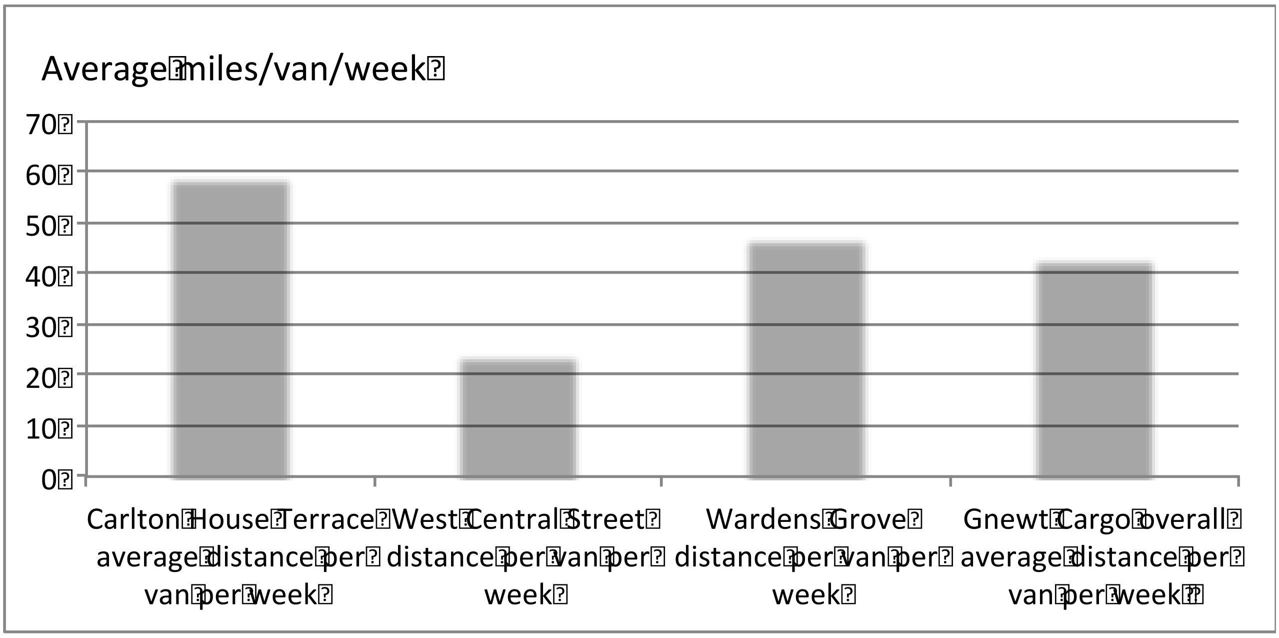
Time windows for delivery	08:00-18:00 is the main time window for deliveries in Central London. The driver carries out the deliveries in the most logical geographical order. In a few cases, it is necessary for the driver to come back to the same street later in the delivery round to deliver to another client. This is due to delivery time windows that are not coherent for all clients in the same area. 08:00 First drivers are leaving 10:00 Almost all drivers are out on delivery trips 18:00 Most drivers are back to the depots 19:00-20:00 Last drivers are returning to the Gnewt Cargo depots
Trolley	2 wheel trolleys are in use by some drivers.
Walking	Long walking time. Frequent longer walks on the footway, few crossing the street, because the permitted loading space is not situated close to the entrance of the client. Longer time needed for obtaining the delivery signature from the clients.
Van mileage and age	About 3,000 miles/year. Fleet age is mostly below 4 years.
GPS use	Only one vehicle is equipped with a GPS on-board unit with data recording and telematics transferring to the head office.
Handheld device, other IT and software, driver knowledge	Each client gives Gnewt Cargo its own hand held device for signature and proof of delivery. No mix of goods into one single van for the operations were recorded for this Agile Gnewt Cargo Category 1 demonstration. No round optimisation or tour scheduling support system is in use. Postcode order is finalised by the driver according to his knowledge. Driver knowledge takes about 2-3 months to build up to full coverage of the area and mature operational efficiency.

Source: Agile demonstration 2014-2015

General distance data

The average distance per van per week was collected and calculated for three depots and selected vehicles. This distance was recorded during the period 5 to 9 January 2015 for the Hermes delivery business (see Table 3). The aim was to assess the difference between Carlton House Terrace and other depots. The average trip distance is slightly higher for Carlton House (59 miles per van per week) than for Gnewt Cargo average (43 miles). This is because two of the rounds started from Carlton House, and covered an area beyond St James Park that is more distant than most other delivery areas.

Figure 7: Average distance in miles per van per week, 5-9 Jan 2015



Source: Agile Gnewt original data collection, January 2015

Table 3 presents the details of this January record, allowing a comparison of the logistics performance of the 3 depots, for a sample of 4 to 5 vans representative for the typical delivery business of each depot. The average distance varies between 0.050 and 0.200 km per parcel. The overall average distance for the whole business is estimated at 0.135 km per parcel delivered. In this January period, each vehicle drives on average not more than 43 miles a week in Central London.

If this would be expanded to a whole year of business, assuming 50 weeks of deliveries per year (no business on bank holidays), the average annual distance per van would be approximately 2150 miles. This is about 5 times lower than the UK average urban freight van driving distance, which is approximately 10,000 miles per year.

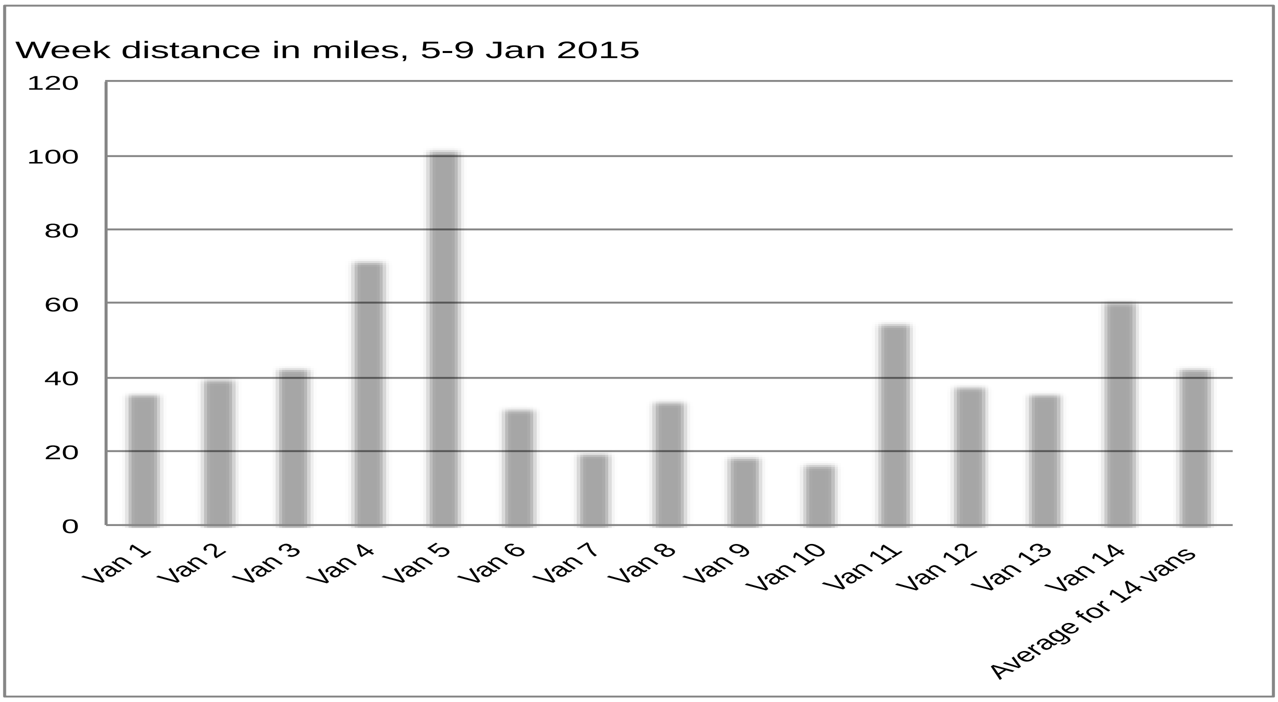
Table 3: Delivery performances of the Carlton House depot, compared to 2 other depots, rounds made for the Hermes business, 5-9 Jan 2015

	Week distance in miles	Week distance in km	Parcels delivered during week	Distance in km/ parcel
Carlton House Terrace depot: 5 Hermes delivery vans				
Van 1	36	60	572	0.106
Van 2	40	67	463	0.145
Van 3	43	72	425	0.170
Van 4	72	121	582	0.208
Van 5	102	171	348	0.492
Total 5 vans Carlton House	293	492	2390	0.206
West Central Street depot: 5 Hermes delivery vans				
Van 6	32	54	707	0.076

	Week distance in miles	Week distance in km	Parcels delivered during week	Distance in km/ parcel
Van 7	20	34	586	0.057
Van 8	34	57	816	0.070
Van 9	19	32	1006	0.032
Van 10	17	29	702	0.041
Total 5 vans West Central Street	122	205	3817	0.054
Wardens Grove depot: 4 Hermes delivery vans				
Van 11	55	92	641	0.144
Van 12	38	64	1061	0.060
Van 13	36	60	517	0.117
Van 14	61	102	560	0.183
Total Wardens Grove	190	319	2779	0.115
Totals for 14 van rounds Gnewt Cargo 5-9 Jan 15	605	1016	8986	0.135
Averages for 14 van rounds Gnewt Cargo 5-9 Jan 15	43	73	642	0.135

Source: Agile Gnewt original data collection, January 2015

Figure 8: Distance per van per week for a sample of 14 vans, 5-9 Jan 2015



Source: Agile Gnewt original data collection, January 2015

There is a factor 5 difference between the shortest and the longest average week distance for the same type of parcels delivery business for the same client. This can be explained because each driver is covering a different small area of Central London, and these destination areas are more or less distant from the depots of origin.
In January 2015, the West Central Street depot operation seems to have a high performance in terms of high number of parcels per van and a high efficiency in terms of low distance per parcel. The spread factor of the efficiency, measured in km per parcel, is more than a factor 15 between the most efficient (0.032 km per parcel) and the least efficient (0.492 km per parcel) delivery round. This is an indicator about cost efficiency as well. It appears that the Carlton House Terrace depot does not show very high efficiency values.

General energy data

Table 4 presents the energy analysis of the Hermes business of the Agile Gnewt Cargo project operation at 3 depots, with kWh recorded in the period 5-9 January 2015. The diesel fuel consumption is an average of the Hermes' fleet for the year 2014.

This impact analysis compares diesel vans with electric vans, with electric vehicle information collected in the one-week period of January 2015. This analysis was repeated in April and May 2015.

Table 4: Energy price and efficiency analysis at all 3 Gnewt Cargo depots, 5-9 Jan 2015

	l/100km	Distance mi/day	Distance km/day	Fuel price £ per litre	Fuel used l/day	kWh/mile	Elec. price £/kWh	Energy price £/day
Diesel van	10	8.4	13.5	1.3	1.35			1.75
Electric van			13.5			0.278	0.1	0.22

Source: Agile Gnewt original data collection, January 2015

The results of Table 4 are similar to, and confirm, those of Table 1. As for the results of the energy analysis presented above in section 2.1 for the Carlton House Terrace depot, the costs of energy for the electric vans are very low, when compared to the fuel costs of a similar diesel van (87% lower for electric than for diesel).

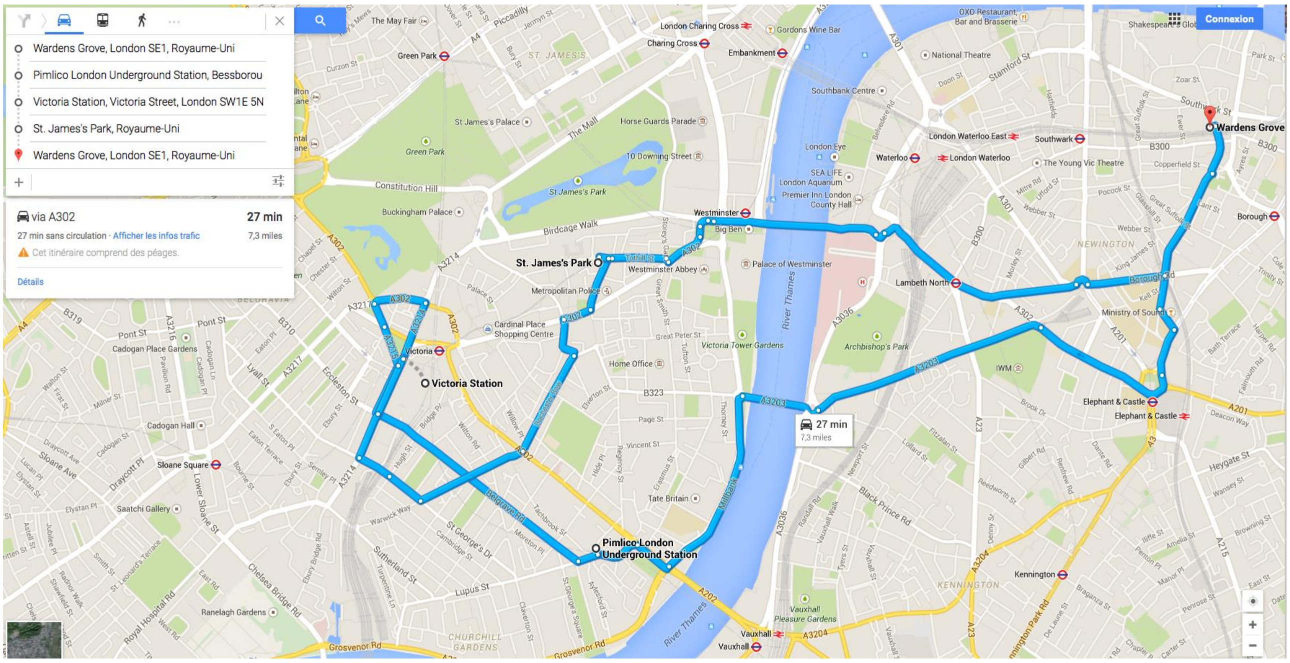
3.2.2 Impacts of using Gnewt Cargo instead of other operators

The main impacts of using Gnewt Cargo depot instead of the depots of the clients are twofold:

- the timing of journeys and the roads on which vehicle activity takes place, and
- the reduction in total distance travelled.

To illustrate the changes, the most relevant types of trips are illustrated in Figures 9 to 11. One starts from the Gnewt Cargo Wardens Grove (After, see Figure 9). The second trip starts from a depot in Enfield (Before, see Figure 10). Both delivery trips start in the morning in peak traffic.

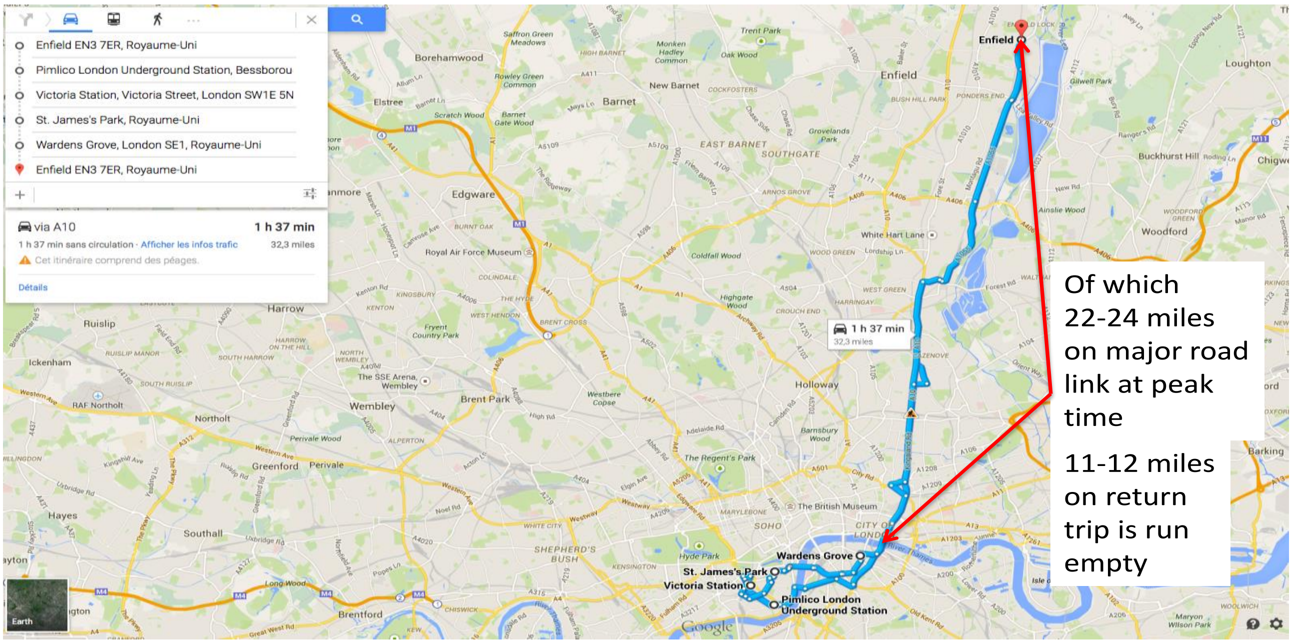
Figure 9: After: Electric delivery round to Pimlico & Victoria area, starting from Wardens Grove depot



Source: Agile Gnewt Cargo demonstration 2014-2015

The Gnewt Cargo electric delivery trips start in Wardens Grove and delivers to the Pimlico and Victoria area. In Figure 9, the distance covered by electric vans for daytime delivery represents about 8 to 10 miles per day.

Figure 10: Before: Diesel van delivery trip to Pimlico & Victoria area, starting from Enfield depot.

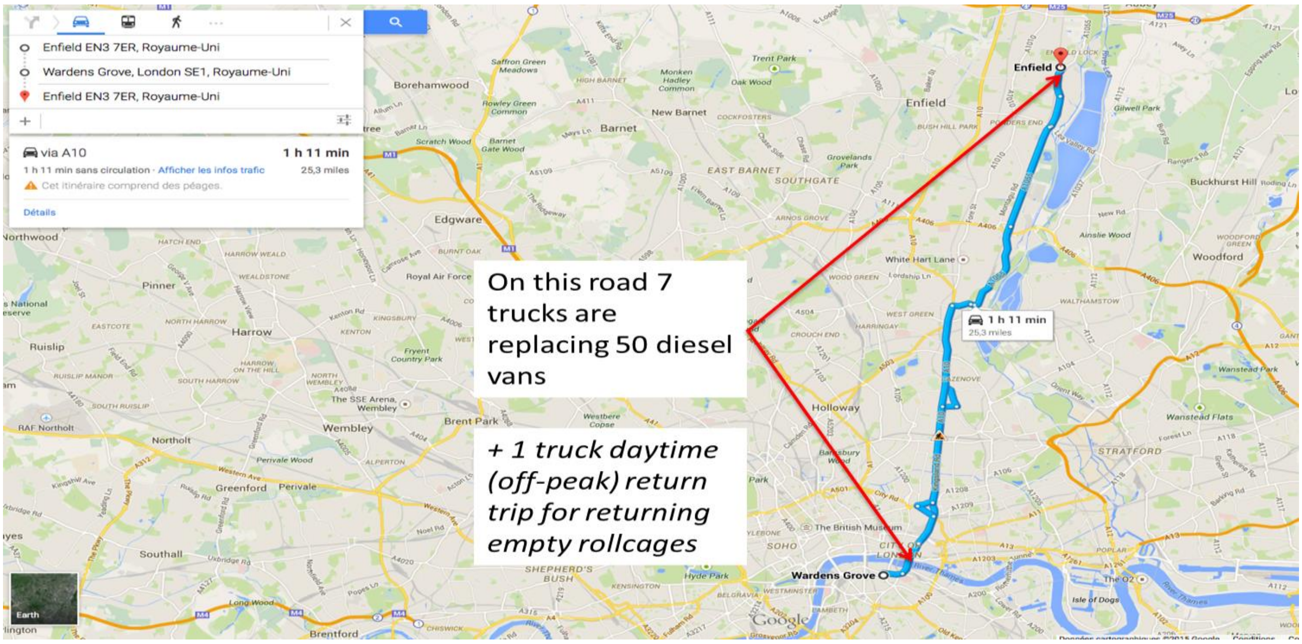


Source: Agile Gnewt Cargo demonstration 2014-2015

In comparison, the diesel van trips that were replaced by electric vans since August 2014 (see Figure 10) cover a distance of about 32 miles per day, and the vast majority of the trip distance (22 to 24 miles) occurs on a major road (main axis) linking the area of Enfield in the North of London with Central London. In the after situation, an important type of trip takes place between Enfield and

Wardens Grove, which is the truck trip between two depots. This truck trip occurs now at night (see Figure 11).

Figure 11: After: Diesel truck night delivery return trip from Enfield to Wardens Grove depot



Source: Agile Gnewt Cargo demonstration 2014-2015

In the before situation, 50 diesel vans used to travel from the suburbs to Central London and vice versa on the main road during peak time traffic in the morning and in the afternoon. Now, instead of this, 7 trucks travel at night during off-peak traffic and 1 truck travels during the day to pick up the empty roll-cages and bring them back to the Enfield depot.

This type of truck trip between two the company depots and the Gnewt micro-consolidation centres are very efficient in terms of logistics efficiency and externalities. They show a beneficial impact on total distance during peak traffic, night traffic, load factor, empty distance and fuel use. To better assess the impacts and benefits in detail, a before-after analysis was carried out using the data collected.

Timing and how representative are these impact data for London as a whole?

This section presents the results of the before-after data collected in the Agile Gnewt Cargo project in the period 2014 and 2015. The data was collected in a way that ensured it was representative of the entire business of Gnewt Cargo and of the whole diesel urban freight parcels delivery business in London (before). So the dataset is homogenous, consistent with other studies and is focused on typical day to day practices in urban freight business in London. The period of data collection is either annual, for two months, one week or one day. The data collection time period is specified when presenting the results.

At the end, the most central KPI is to look at the different impacts per parcel. Therefore, most of the data presented aims at answering the question: What are the quantified benefits per parcel delivered?
The data collection for the 'before' situation is for the period 2014. The data collection for the after situation is for the period 2014 and 2015 mostly in form of annual average values. Some datasets were collected over a period of one week, others including the average diesel fuel use and the kWh

electricity consumption were recorded over an entire year, others including the number of parcels handled were recorded over three separate periods of one week.
Other types of data such as the van round observation data were recorded over one day. When selecting this day, it was important to select a day that was a ‘normal’ business day, and which used a Renault Kangoo ZE as this is the van most commonly used by Gnewt Cargo. The main ‘after’ record for the impact assessment was collected in April and May 2015.

As previously explained, the results focus on the Hermes and Wardens Grove data. The TNT depot data were found to be similar to the Hermes data in terms of distance reduction and logistics processes. Therefore the Hermes data were used in case there are no other data available.
Box 2 shows what “before” and “after” means for the Case Study 2.

Box 2: Definition of “Before” and “After” in Tables & Figures of Case Study 2
In all Tables mentioning “Before” and “After”, both words always refer to the two standard business situations:

- Before means before Agile Gnewt Cargo started: the diesel business with a DAF FT45 7.5t delivery trucks, starting at a depot in Enfield, making deliveries in Central London
- After means after Agile Gnewt Cargo started: the electric van delivery business with trucks coming from Enfield to the Gnewt Cargo depots at night + electric vans starting from the consolidation depot at Wardens Grove, making deliveries to clients in Central London

On 27 January 2015, a day of ‘After’ data collection (raw data) was performed, for qualitative information gathering purpose. Interviews, observations and quantitative records were made on a typical round trip to a Central London area, starting from Wardens Grove depot. Nothing out of the ordinary and no disruptions occurred; so this can be considered to be a representative, typical round trip of the Gnewt Cargo parcels delivery business for Hermes.

These qualitative and quantitative results can be considered valid and representative not only for all other trips of the company but also for the whole parcels delivery business in Central London in general. Other similar data collection was made in the past with Office Depot deliveries and the patterns and findings are very similar.

The main objective of this one-day data collection was to assess the logistics performances and to measure the efficiency of the day to day parcels delivery business in Central London. Table 5 below presents the details of this typical round.

Table 5: Round data on logistics and delivery performance, monitored on one typical day, 27 Jan 2015, & on annual data

Type of vehicle	Nissan e-NV 200
Type of vehicle round	Multi drop round, with deliveries only
Load	125 parcels at departure
No. of stops per round	About 60-80 in a normal day
No. of rounds per day	1 (in other rare cases of Gnewt Cargo deliveries, an additional delivery round occurs in the afternoon)
Load factor at departure	The electric van was having a >90% load factor by volume on departure, which can be considered

	as 100% load factor.
Distance between depot and first stop, (stem mileage)	1.5 km
Mean **distance between stops in the destination area**	50-100 metres
Location of origin and destination, and location of the stops	Round starting from Wardens Grove, delivery stops in Borough of Westminster, Pimlico area, no collection
Start and end time of vehicle round	09:56 to 13:16 (observation time) 16:30 arrival time at depot
Round time	11 minutes in the morning from depot to first stop; about 6 hours delivery time.
Delay time	No delays
Vehicle speed, driving time and stop time	Average speed (driving time only): about 4 miles per hour on average, with an average driving time of about 1-2 minutes between 2 stops, and a maximum time between 2 stops of 4 minutes driving time, occurring after the first stop. Total delivery time observed: 3h20 **Driving time:** 50 minutes (1 Quarter of the Total delivery time is spent driving on the road and impacting traffic) **Stop time:** 2h30 (3 Quarter of the Total delivery time is spent with the vehicle stopped at the client location, either on a public parking space or at a private loading bay) Stop time was measured as the time taken between motor stop and motor start, with an average of 5 ½ minute per stop.
Dwell time (waiting at customer location)	None during the round. Each delivery could start immediately after arrival at the address of destination.
Vehicle crew size	1
Delays	No traffic jams towards delivery area in West Central London in the morning, no delay time, and the first delivery can be performed straight away on arrival.
Parking and Penalty Charge Notes (PCN)	Drivers are required to relocate their vehicle many times a day to avoid a ticket issue. PCNs are issued frequently, and take significant amount of management time to process. 90 % of PCNs that were challenged during the demonstration have been discarded.
Phone calls, disruptions	No phone call, no disruption and no change in delivery round operation took place on that day.
Driver knowledge	No case was observed where the driver would need to search for a new customer location. Searching time was less than a minute per client, if any.
Empty running	Empty running is part of the urban freight business that cannot be avoided, except if collection of parcel or failed delivery is occurring. The van was not empty even after the last stop, when returning to the depot, because of 2 failed deliveries.

Source: Agile demonstration 2014-2015

3.2.3 Impact Assessment and data analysis of the multiple depots Case Study

For the quantified impact assessment of the Case Study 2 on multiple depots management, a separate set of data was collected. The following Tables provide quantified evidence of the impacts of the Agile Gnewt Cargo demonstration focussing on the multiple depots Case Study. The upper line of the

Tables refers to the data concerning the 'before' situation, the bottom line to the 'after' situation. These Tables are based on records gathered at Wardens Grove depot, DX depot and West Central Street depot in April and May 2015, during 2 months. The data cover the Hermes, TNT and DX delivery business. For the Before situation, most of the average values of the Hermes fleet data for the year 2014, collected at the Enfield depot, were used.

Table 6 presents the before-after changes in logistics, which are the basic starting points for all impact calculations presented in following sub-sections 3.2.4 to 3.2.13. Main fact here is that there was no change in the total number of vehicles used for the delivery business. This is due to the fact that the total time spent to deliver one parcel to one client is very difficult to reduce in the frame of the single carrier delivery business.

Table 6: Before – after data on fleet vehicle numbers and logistics systems in use

Units **Description of logistics system**	**Number of trucks during daytime**	**Number of trucks at night**	**Number of electric vans**
Before: DAF FT45 7.5t trucks + depot Enfield	35	0	0
After: Trucks coming from Enfield + Electric van delivery + depot Wardens Grove	1	7	35

Source: Agile demonstration 2014-2015

Further description of the logistics systems 'before' and 'after' are presented in Figure 4, Table 2, Box 2, Table 5, and in the Monitoring Report M7. There were no changes in delivery vehicle load sizes, because it was essential to maintain the comparison on a like for like basis, and there was no desire to change operations from the point of view of the clients (Table 7). All the parcels that are delivered in the before situation continue to be delivered in the after situation. This is an assumption that is consistent with current business practices in London.

Before the demonstrator received these new contracts for deliveries in Central London for Hermes, TNT and DX, the goods of these clients were previously delivered by another carrier. Before and after the contract change, the old carrier and Gnewt Cargo would be receiving the exact same amount of parcels per day, on average over a year period, from the client, because this total number of parcel is the freight demand generated by this client.

Table 7: Before – after data on average load unit

Units	Parcels per day in delivery trucks	Parcels per day in trucks at night	Parcels per day in electric vans	Total parcels delivered per day	Index parcels per day
Before	4500	0	0	4500	100
After	0	4500	4500	4500	100

Source: Agile demonstration 2014-2015

Like in all other before-after surveys, the freight demand is assumed to remain constant and therefore the total number of parcels is identical: in this case a full subset of data was recorded for 4500 parcels/day during 2 months.

Table 8: Before – after data on distance according to vehicle & trip type, and load

Units	km/day in daytime trucks	km/day in trucks at night	km/day in electric vans	km/day in total all vehicles	Distance in km per parcel	Index distance per parcel
Before	1724		0	1724	0.38	100
After	42	293	484	819	0.18	48

Source: Agile demonstration 2014-2015

One of the major impacts of using the Gnewt Cargo micro-consolidation centre logistics system instead of the previous logistics system is the reduction in the overall distance travelled in London (Table 8). The distance reduction is best calculated in kilometres per parcel (km/parcel), and the result is a before-after reduction of 52%.

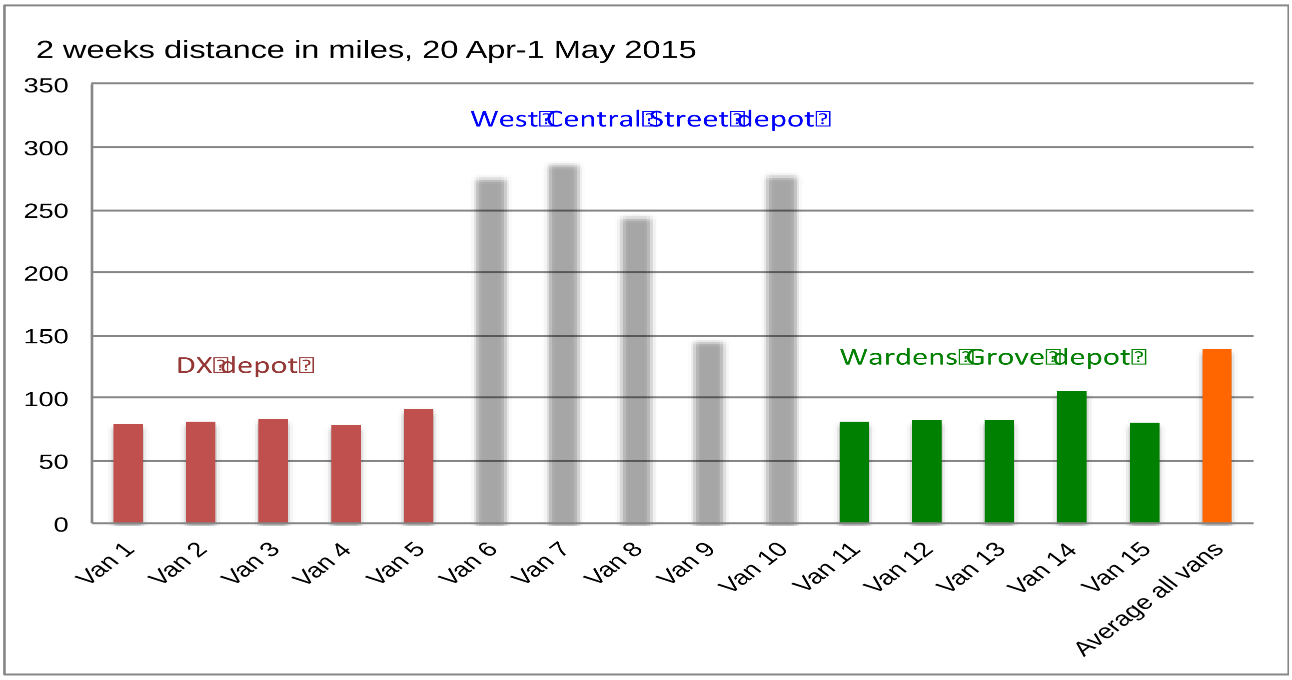
This result for distance travelled is expected to be potentially improved in the future, because currently trucks travel at night, bringing the parcels from the regional Hermes depot in Enfield down to Wardens Grove, and these trucks are relatively small 7.5 tonne trucks. Instead of having 7 trucks at night, all parcels could potentially be carried with 3 larger lorries, and this would further reduce the total distance driven per parcel.

3.2.4 "After": Distance data analysis for April-May datasets recorded at 3 depots.

The impacts on distance travelled have been calculated in detail from of the raw data of delivery trips recorded during a 2 weeks (10 weekdays) business period from 20 April to 1st of May 2015. An overview is presented in Figure 12.

Details, explanations and analysis are presented in Tables 9 to 11.

Figure 12: Overview: Average two-weeks distance from 20 April to 1st May 2015



Source: Agile demonstration 2014-2015

The DX depot showed an average delivery trip distance per parcel that is lower that the Gnewt general average, about 100 metres per parcel (Table 9). This DX business shows a good result, also because the vans of Gnewt Cargo can start their round directly from the DX depot, so there is no truck trip to be added and no diesel vehicle at all used for the entire last mile delivery section of the supply chain.

Table 9: DX depot mileage data analysis 10 weekdays 20 Apr-1 May 2015

Van	km total	km/day	Parcels delivered during period	parcels/ day	km/ parcel
Van 1	127	12.714	1370	137	0.093
Van 2	130	13.036	1208	121	0.108
Van 3	134	13.358	1421	142	0.094
Van 4	126	12.553	1085	109	0.116
Van 5	146	14.645	1437	144	0.102
Average	133	13.261	1304	130	0.102

Source: Agile demonstration 2014-2015

The TNT business delivered from the West Central Street depot show a much longer trip distance than the other delivery businesses of Gnewt Cargo (Table 10). The average is 0.580 km per parcel, almost a factor 6 when compared to the DX business. Three causes explain this result: The TNT business has a lower number of parcels per day than the DX operation, a lower number of deliveries per stop (lower drop density) and a more distant delivery area.

Table 9: DX depot mileage data analysis 10 weekdays 20 Apr-1 May 2015

Van	km total	km/day	Parcels delivered during period	parcels/day	km/parcel
Van 6	446	44.579	698	70	0.639
Van 7	463	46.349	745	75	0.622
Van 8	396	39.590	679	68	0.583
Van 9	237	23.657	489	49	0.484
Van 10	449	44.901	782	78	0.574
Average	398	39.815	679	68	0.580

Source: Agile demonstration 2014-2015

For the Hermes delivery business starting from Wardens Grove, the distance is reduced further down, with an average of 76 metres per parcel (Table 11). This is due to a much higher number of parcels per day (about 190 parcels per day on average). Recording of the data of the Wardens Grove van fleet started in August 2014 and the variation to date is between 100 and 600 parcels per day.

The variation reported from the Hermes Enfield depot business ('before') with diesel vans are between 150 and 400 parcels per day, depending on the rounds and the time of the year. Thus, at this stage of the project, and with the current set of data recorded, no major before-after difference in driver productivity can be evidenced. This is mainly due to the fact that the time spent at the final customer building making deliveries cannot be reduced.

This time is spent by the driver processing the delivery, not driving on the road, and therefore it is very difficult to increase substantially the driver productivity in terms of an average total number of parcels delivered per driver per day. Compared with other business data gathered in London and in other European projects, the variation between 100 and 600 parcels per day can be explained because of the type of clients and the drop density. Compared to other case studies, 190 parcels per day can be considered as high productivity.

Table 11: Wardens Grove Hermes mileage data analysis 20 Apr-1 May 2015

Van	**Total km**	**km/day**	**Parcels delivered during period**	**parcels/day**	**km/parcel**
Van 11	130	13.036	1154	115	0.113
Van 12	132	13.197	2032	203	0.065
Van 13	132	13.197	2022	202	0.065
Van 14	169	16.898	2458	246	0.069
Van 15	129	12.875	1958	196	0.066
Average	138	13.840	1925	192	0.076

Source: Agile demonstration 2014-2015

Table 12 presents another set of average data collected over two other periods. The first is August to December 2014, which is corresponding to the peak Christmas business period, and the second is January to May 2015. This additional dataset allows to show that the data collected over a shorter period of two weeks is corresponding well to the overall average data collected over a longer time frame.

Table 12: Average one week mileage analysis for 3 depots, Winter 2014 and Spring 2015

Period of raw data record	Average weekly miles per van	Average parcels per van during one week	Average weekly km per van	Average km/ van/ day	Average parcels/ day	KPI Average distance in km/ parcel	Index km/ parcel
Aug-Dec 14	43	642	73	15	128	0.113	100
Jan-May 15	69	651	112	22	130	0.171	152

Source: Agile demonstration 2014-2015

Main difference between the data recorded for the period August-December 2014 (average from sample in week 05-09 January 2015) and January-May 2015 (average from sample in weeks 20 April-1 May) is that there is a 52% increase in the average distance per parcel. Average weekly miles increases around 50%, but number of parcels remains stable at 128 and 130 per day. One reason for this is the overall decrease in demand, compared to the Christmas peak period, when measured in terms of total number of parcels delivered per week.

The other reason is the inclusion of TNT and DX business for the second period of data collection in April and May 2015, while the January data were only for the Hermes business. The effects of these changes are a decrease in density of clients and therefore longer trips for the same amount of parcels. The impact assessment data below is for all depots and uses the central value of 13.8 km per day as average distance driven for Wardens Grove depot.

3.2.5 Monitoring data on Energy and CO_2 in April-May 2015

Table 13: Agile Gnewt Cargo demonstration data on fuel use and CO_2

	Litres diesel/ day	kWh/ day	kg CO2e/ day	kg CO2e/ parcel	Index kgCO2e/ parcel	Reduction in CO2e/ parcel
Before	431	0	1336	0.297	100	-
After	50	525	156	0.035	12	88%

Source: Agile demonstration 2014-2015

The indicator "Litres of diesel per day" refers to the fuel use by all trucks in the fleet as a sample performance recorded "before" and "after" and presented in Tables 13 to 15. The "kWh/day" uses the reading of the electricity metering system at Wardens Grove, and extends this value to all electric vans and all depots of Gnewt in the situation "after". Other key values used are presented in Tables 14 and 15.

The column entitled "kg CO_2e per day" is the total CO_2 emitted by all vehicles during one day. The emission factor used is the standard UK diesel conversion factor of DEFRA 2015, where 1 litre of diesel fuel = 3.1 kg CO_2e (Table 13). The column entitled "kg CO_2e per parcel" relates to the emissions from the actual deliveries performed.

The column entitled "Index" and the column entitled "Reduction" are derived from the column entitled "kg CO_2e per parcel", but provide a clear view of the results. So the reader can understand that, when speaking about an 88% reduction in CO_2 per parcel, this means that the index 100, from which the reduction is calculated, corresponds to the 297 grams emitted per parcel in the "Before" situation.

3.2.6 Assumptions used for the impact assessment

At night or in early morning, daily truck operations are performed between the clients' depot and the depots of Gnewt Cargo. Seven 7.5t diesel trucks of the type DAF FT45 come from the Hermes depot in Enfield to Wardens Grove at night/early morning. Fuel use data were estimated. The diesel CO_2 and costs were calculated from these estimates.

It is assumed that no CO_2 is emitted from the use of electricity for the electric vans, because of the purchase of electricity from 100% regenerative energy sources. The use of carbon intensive production method for the vehicle and battery manufacturing are considered not relevant and out of scope (out of the limits of the system of observation), because the emissions are not taking place in London and should be accounted for the carbon account of the manufacturing industry. But these emissions are relevant for the observation of the logistics and transport sector as a whole, and would need to be taken into account when considering the global relevance.

The same remark applies for all other carbon and air pollutant emission occurring along the supply chain and the life cycle of the electric vehicles, as compared to the diesel vehicle. Other studies have documented this question of the impacts very well, comparing diesel with electric vehicles and other technologies (AEA, 2012). The average number of staff per truck is uncertain as this information could not be obtained from the client - it is assumed that one third of a working day is spent by each truck driver to deliver at night/early morning for the truck trip one way from Enfield to Wardens Grove.
For the pollutant emissions, the assumption made is that the average values of the National Inventory (NAEI) for UK are also valid for the vans and trucks observed. These NAEI values are expressed in average NOx per km. This allows the calculation of the total NOx emissions driven in before and after situations.

Tables 14 and 15 present the findings of the data collection for all costs and impacts values that are remaining constant across all topics, costs, distance, etc.

Table 14: Constant values used for calculation of costs and impacts "before" and "after"(a)

Distance Before: Delivery trip Enfield depot-city centre border. in km	Distance After: truck from Enfield Depot to Gnewt depot. in km	Distance before and after: delivery trip part in city centre/van round trip in km	Fuel use DAF LF45 truck for daytime trips in l/100km	Fuel use. DAF LF45 truck night trips in l/100km	Emission factor kg CO2e/l diesel
17.7	20.9	13.8	25	15	3.1

Source: Agile demonstration 2014-2015

Table 15: Constant values used for calculation of costs and impacts "before" and "after" (b)

No. Staff per van or per truck	Staff costs/day in £	Price £/l diesel	Fixed costs for vans + depots+ variable others in £/km	Electricity price in £/kWh	Electricity use in kWh/day per electric van	Annual Wardens Grove depot rental costs (included in fixed costs) in £
1.0	66	1.2	1.5	0.12	15	200,000

Source: Agile demonstration 2014-2015

The data on number of staff per van is taken from the Gnewt Cargo business practices in all the years 2009-2015. While this number might fluctuate a little, the standard rule remains 1 driver for 1 van. The staff costs are £66 per day as an average for 2014 including gross salary costs.

The fuel costs is an average diesel price for UK for the year 2014. The electricity price is updated for May 2015 and is the price paid. The fixed costs include all other costs except staff and energy. This value was calculated as a standard value for 2014 across all businesses, all vans and all depot operations. The fixed costs for running the depots of the clients could not be obtained. An indication of the highest position of the fixed costs is given with the rental costs of the depot in Wardens Grove.

The fixed costs for the annual spent on vehicle purchase have proven identical "before" and "after". It is likely, however, that the total costs of all depots increased in the operations "after". It is also likely that the additional annual depot rental costs are compensated by a series of costs reduction in other areas such as vehicle taxes, Congestion Charge, etc. The absence of a fully detailed costs breakdown for all depots and all vehicle operations has led to the assumption that the fixed costs for vans, depots and variable other costs can be considered identical "before" and "after".

3.2.7 Before-after impact data on staff changes and costs reductions

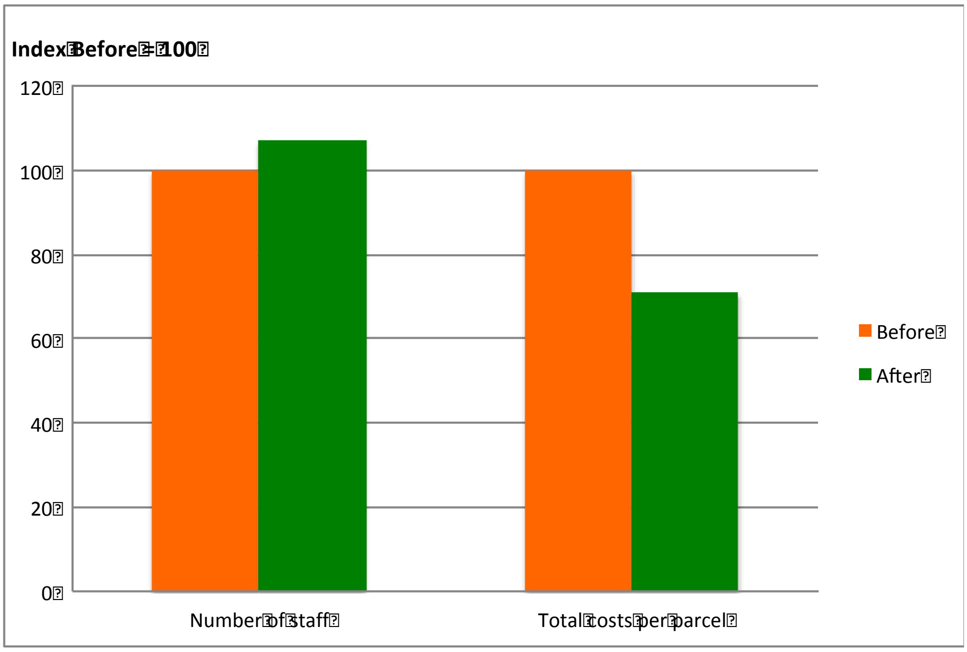
Table 16: Data on staff changes and costs (in £)

	No. staff	Index no staff	Parcels delivered per staff per day	Total costs per staff/day in £	Total costs energy/ day in £	Other fixed and variable costs /day	Grand total costs/ day	Total costs per parcel	Index total costs per parcel
Before	35.0	100	129	2320	517	2585	5422	1.20	100
After	37.4	107	120	2479	123	1229	3831	0.85	71

Source: Agile demonstration 2014-2015

Employment effect and total costs effects were calculated for the operations at Wardens Grove, with average employment and costs data recorded during one year in 2014. An overall business cost reduction of 29% was estimated for the Agile demonstration, when measured as costs per parcel delivered (Table 16, summarised in Figure 13). An average staff increase of +7% was estimated, which can be viewed as a beneficial employment effect. The additional staffs are required for the truck leg, at night.

Figure 13: Before-after impact summary of demonstration for staff employed and total costs per parcel



Source: Agile demonstration 2014-2015

The business model is competitive on the market, sustainable in terms of long-term profitability.
The before-after difference in the other fixed and variable costs per day are a direct result of the reduction in miles travelled, since the costs are calculated with a fixed assumed ratio of £1.5/km, as presented above in Table 16.

The exact operating costs for each vehicle category used by Gnewt Cargo and its clients could not be determined. Instead, an average operating cost value for all costs other than staff and energy was obtained.

3.2.8 Detailed distance reduction impacts of the Agile demonstration in the period April-May 2015

One of the main traffic impacts is a reduction in the number of vehicles and the vehicle distance on major roads in London. Due to the larger trucks only completing the trucking trips at night (a return distance is 25 miles) these larger trucks have been removed from London's roads in daylight/peak hours. In the January 2015 trips, for Hermes only, 7 trucks replaced 50 diesel vans. The overall number of vehicles on the major road axis was reduced by about 86% and the total distance driven on these major roads reduced from 1200 to 154 miles per day, a reduction of 87%. In April/May data records, due to the lower number of vans in use, the data for major roads still showed a reduction in distance travelled of 78%.

Table 17 shows an overall reduction in daytime traffic of 52% in terms of distance travelled. The night-time traffic occurs on the main axis, and when it is compared to the more congested daytime traffic, the lack of congestion and the much shorter driving time should lead to a net reduction in fuel use per miles for the diesel truck trip. However, due to uncertainty of this effect, the same diesel fuel use value was used for the impact calculations.

Table 17: Data on detailed distance reduction for daytime traffic in Apr-May 2015

	Day time distance in km	Night time distance in km	Total distance in km	Index day time distance	Reduction day time distance in %
Before	1,724	0	1,724	100	-
After	484	335	819	48	52%

Source: Agile demonstration 2014-2015

3.2.9 Shift to night traffic on the main axis

Seven return truck trips at night have replaced 50 diesel van trips during peak traffic in January, and 35 diesel van trips in April-May (see the map of the trips replaced in Figure 10). The trucks arrive at the Central London depots between 03:00 and 06:30. So on the major road axis, outside the delivery zone, and for journeys between suburban depots and Gnewt micro-consolidation centres, when compared to the previous total trips, the traffic occurrence during peak traffic in the morning is reduced to none, a 100% reduction.

During the day, around midday, only one truck is traveling on the main axis. This is the only residual daytime traffic on the main axis. Therefore, the before-after comparison shows a reduction in number of vehicles in daytime traffic on the main axis of 98% in January and 97% in April-May. The night-time traffic is increased by 7 trucks, which are covering a total of 335 km per night. The daytime distance is now mainly the electric vans in Central London. Overall, when accounting for all vehicles and comparing the whole system of operations before and after on a like for like basis, the distance reduction on London roads is 52%. The reduction of daytime traffic is completed by another effect, the reduction of empty running distance.

3.2.10 Reduced distance run empty

On an important part of the "Before" truck daily trip, the return trip back to the depot after having delivered the last client of the day, the diesel truck is running empty, and the empty distance is about 11 to 12 miles. This empty distance is reduced to about 1 mile for the delivery round of the electric vans. The empty distance of the trucks is limited to 12 miles per day, on their return trips from Wardens Grove to the depot in Enfield.

It is estimated that there is about 77% reduction in the distance run empty between the situation before and after the introduction of the Gnewt Cargo business (Table 18).

Table 18: Data on detailed reduction for empty running distance in Apr-May 2015

	Empty running distance	Empty running in % of total	Index empty running distance	Reduction empty running distance in %	Loaded distance	Total distance
Before	620	36	100	0	1,104	1,724
After	220	27	35	65%	599	819

Source: Agile demonstration 2014-2015

According to data collected in April-May 2015 at Gnewt Cargo, the distance run empty is reduced by 65%. Nevertheless, a small part of the trips cannot avoid being made empty:

- when the trucks of the clients are returning to their depot at night after having delivered the parcel to Gnewt Cargo's depot.

- when the electric vans have finished to deliver the last client of the day and need to return back to the Gnewt Cargo depot, and have delivered all parcels successfully.

3.2.11 Details on the main axis distance reduction

Main axis distance is defined as the distance outside the Central London area of the Congestion Charging zone (see trip map above Figure 10). Central London distance is within the zone. Main axis distance is reduced, but slightly increased distance is observed within Central London.

The distance covered in the Central London area increases due to the last part of the trip made by 7 trucks coming to the Wardens Grove depot at night. Each truck drives about 3 miles between its entering and leaving of the Central London area. This distance is not counted as main axis distance. A total of 21 miles are added to the 400 miles needed to perform the electric delivery rounds in Central London. This corresponds to a distance increase of about 5-7% in Central London (Table 19).

Table 19: Data on distance reduction for main axis, and increase in city centre

	Main axis distance	City Centre distance	Total distance in km	Index main axis distance	Reduction main axis distance in %
Before	1,239	484	1,724	100	-
After	319	500	819	26	74%

Source: Agile demonstration 2014-2015

3.2.12 Reduction in overall distance and in distance per parcel

According to January records, the impact on total distance travelled was 64% in London. In the April-May record, the distance reduction is a little less important, but still a strong 52% (Table 20 for total distance reduction and reduction per parcel). The difference between the January and the April-May records is explained with the fact that having a smaller number of electric van in operation, the total distance cannot be reduced by as much, compared to the situation before, as when the clean fleet is at its maximum peak during Christmas time.

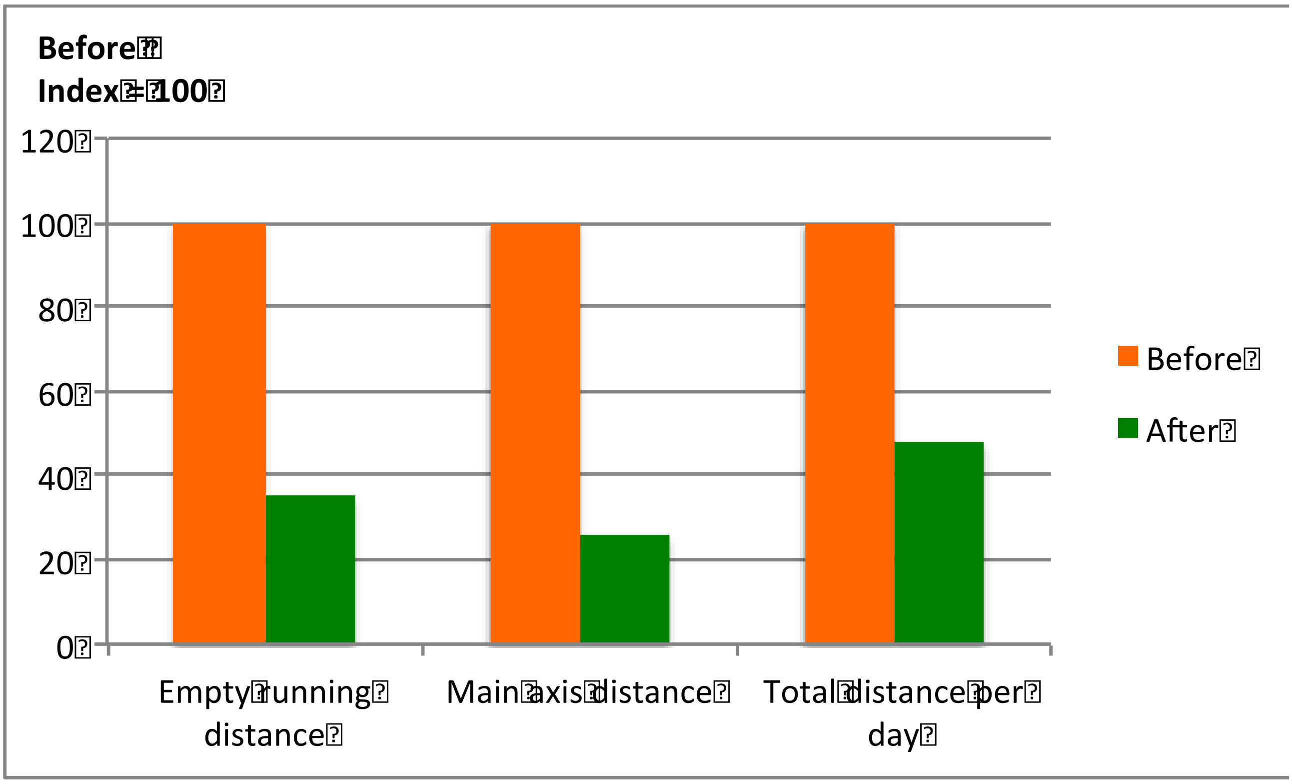
Table 20: Data on reduction for distance driven in London per day, Apr-May 2015

	Total distance per day in km	Index total distance per day	Reduction in total distance per day in %	Total distance in km per parcel delivered	Reduction in parcel distance in %
Before	1724	100	-	0.383	
After	819	48	52%	0.182	52%

Source: Agile demonstration 2014-2015

This overall distance reduction on the roads in London has a major impact because all negative external impacts of freight transport such as congestion, accidents, noise, and air pollution are a direct product of the total distance driven (Allen et all, 2011). The monitoring data report M7 shows the benefits in detail. Figure 14 summarises the different reduction effects regarding distance.

Figure 14: Summary of impact of demonstration on distance and empty running



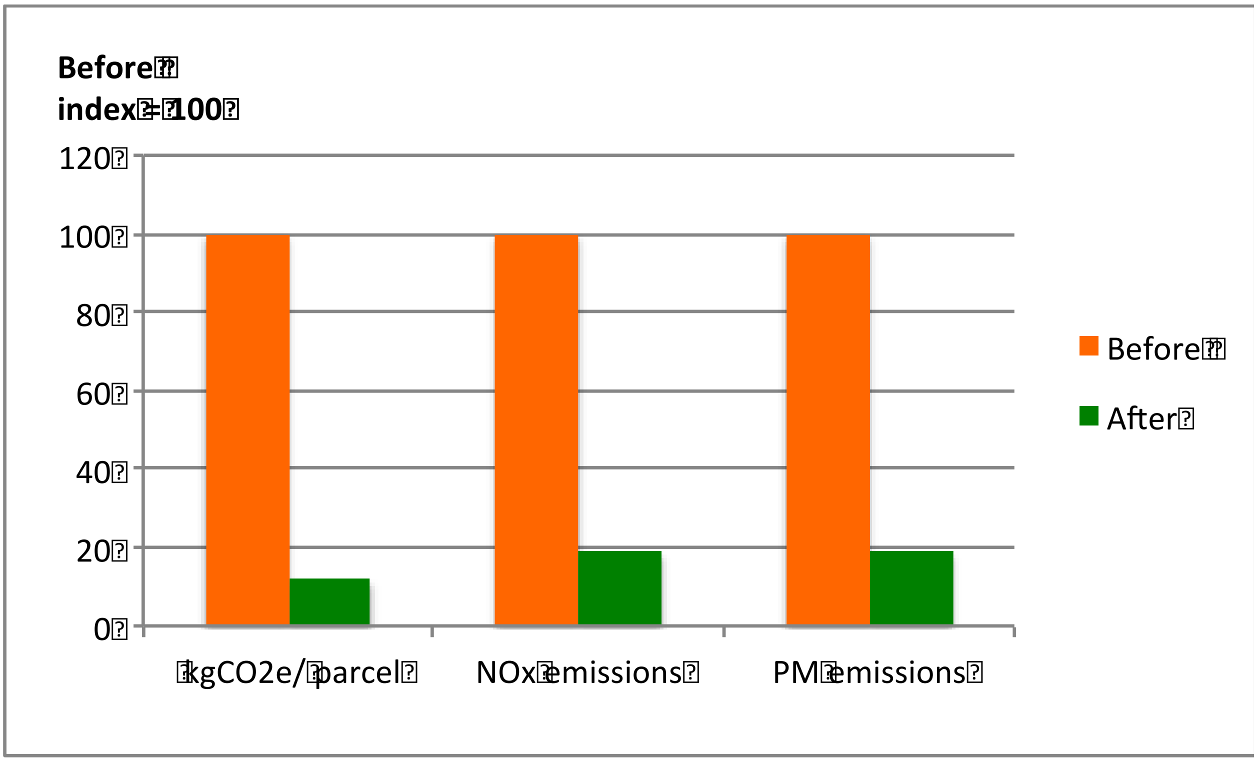
Source: Agile demonstration 2014-2015

3.2.13 Reduction in emissions and air pollution in Central London

One of the main beneficial effects from the point of view of public interest is the strong reduction in air pollution at tailpipe, occurring during daytime and located in the most polluted Central London area shown at the beginning of this Report in Figure 1.

Compared to the before situation, during the whole demonstration, the diesel truck distance is reduced by 81 %. Air pollutants emissions are directly related to distance and the National Inventory NAEI gives emissions values per km. It is assumed that the average air pollutants emissions factors for a standard rigid truck in UK, given by the NAEI values, are valid for the London trucks used before and after the demonstration. Therefore, all major air pollutants NOx, PM_{10}, $PM_{2.5}$, CO, VOC, NH_3, SO_2, Benzene, and N_2O are reduced by 81%, when compared to the situation before the demonstration (Figure 15). Figure 15 summarises the effects of the demonstration on emissions in carbon dioxide and air pollutants, measured at tailpipe in the relevant most polluted areas in Central London locations.

Figure 15: Summary of impact of demonstration on CO2 emissions and air pollutants



Source: Agile demonstration 2014-2015

3.2.14 Lessons learnt from the Case Study 2 trial, and summary impacts of multiple depot management

This Agile Urban Logistics project allowed to demonstrate the beneficial impacts of using multiple depots in Central London locations, together with electric vans for the parcels delivery business.
The main benefit for the public sector is a strong distance reduction and a strong reduction in carbon dioxide and air pollutant emissions at tailpipe.

This positive result was expected from the beginning, but this project allowed the team to give a quantified assessment on the magnitude of the benefits. It gives a benchmark for other projects in London or elsewhere, and it allows us to have data that can be reused for future business cases. Compared to the situation before the business with electric vehicles and depot operations commenced, the total distance travelled, measured in kilometres per parcel, has been reduced by 52%.

This reduction is a like for like comparison to the previous logistics service provider businesses operating directly to customers from depots in outer London. Other external impacts such as contributions to traffic congestion and accidents would therefore be expected to also be reduced, as a result of adopting such a logistics system, as the total distance travelled is an important indicator for these other negative externalities of freight transport.

On major roads, the distance reduction was 87% in January 2015, and 78% in April-May 2015 periods. Night-time operations have replaced peak-time morning operations on the congested main roads from suburban to Central London. As a result of the trial, there has been a 100% reduction of the part of the delivery trips occurring on main roads in London during peak morning traffic. This corresponds to a reduction of between 35 and 50 diesel vans removed from these roads and at these busy times. Empty running distance has been reduced by 65%. Empty trips as such do not represent an issue in parcels services, and when analysing the situation before.

Air pollution, measured for PM, NOx, and other pollutants, was reduced by 81% and CO_2 by 88% in the trial, due to the use of an electric fleet and strong reductions in distance travelled by diesel vehicles. The residual air pollution is due to the night trips of diesel trucks travelling from the suburban depots and unloading the parcels at the Gnewt Cargo depots in central London.

3.3 Case study 3: Comparison of different electric freight vehicles

Main objective of case study 3 is testing the fitness for purpose of different Electric Vehicles for different clients, and assessing the practicality of main types of vehicles, electric vans and e-cargo bikes for different businesses.

The purpose of this case study 3 trial was to:

- Better understand the use of different electric freight vehicles
- Use new IT solution to assess the usage of electric vehicles
- Improve the fleet management for electric vehicles
- Derive practical recommendations

3.3.1 Electric vans and their use

As of June 2015, 3 different electric vehicles tests are completed. The target is that the comparison of the different types of vehicle and performance allow the selection of the most suitable vehicle. For the case study 3, the data collection took place for the 'before' situation and then, when the electric vehicles were introduced into the operation, for the 'after' situation.

Three types of vehicles were been purchased for the trial: Renault Kangoo (see Figure 16), Nissan e-NV200 (see Figure 17), and Postmaster. The Postmaster van was received, but could not resume operation due to registration delays. The two other vans commenced operations and were used successfully. Due to the Christmas peak period for urban logistics, data collection concerning these new vehicles took place in January 2015.

Due to differences in transport demand, the number of vehicles in use is variable:

- Carlton House Terrace depot had 5 electric vans (opened November 2014, ended January 2015).
- Depot in Wardens Grove has a focus on Hermes, 50 vans during peak Christmas period in 2014, 35 vans in Spring 2015.
- Depot in West Central Street is mainly for TNT deliveries, with some Hermes deliveries during Christmas peak. 35 vans were running from this depot during peak Christmas period in 2014, 11 vans and one cycle are in use in Spring 2015.
- DX depot, 8 vans were used during peak Christmas period in 2014, and 5 vans in Spring 2015.

Figure 16: Renault Kangoo of Gnewt Cargo loading at the depot in Wardens Grove in London

Source: Agile demonstration 2014-2015

Figure 17: Nissan e-NV200 of Gnewt Cargo making deliveries in London, Jan 2015

Source: Agile demonstration 2014-2015

The data collected on the new vehicles tends to show a good operational performance. For comparison purpose, the vehicle used before are presented in Figure 18 and 19.

Figure 18: Diesel truck of 7.5t DAF FT45 LF in use by Hermes for urban deliveries "Before"

Source: Hermes 2015

Figure 19: Diesel van of 3.5t Ford transit LWB350 in use by DX before

Source: DX 2014

The type of diesel van shown in Figure 13 was in use by DX for deliveries in London before entering into business with Gnewt Cargo. Figures 20-24 presents the other vehicles in use by TNT, Hermes and Gnewt during the trials.

Figure 20: Peugeot Boxer electric in use for TNT in West Central Street depot

Source: Agile demonstration 2014-2015

Figure 21: Mercedes e-Vito in use for TNT operations at West Central Street depot

Source: Agile demonstration 2014-2015

Figure 22: Aixam Mega in use at Wardens Grove depot

Source: Agile demonstration 2014-2015

Figure 23: Goupil in use at West Central Street depot

Source: Agile demonstration 2014-2015

Figure 24: Toyota Yaris in test at Wardens Grove depot

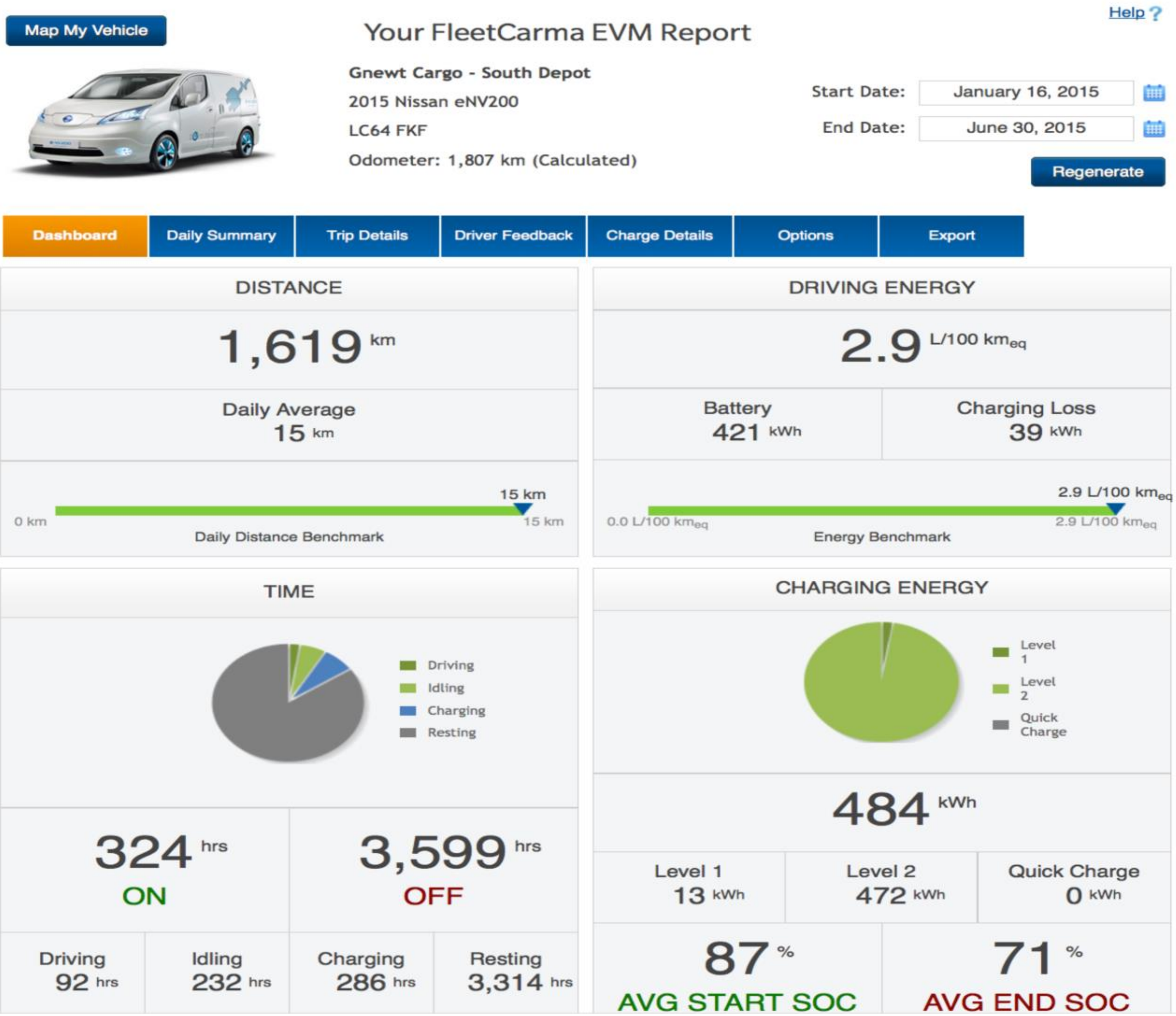
Source: Agile demonstration 2014-2015

Impact assessment data show that the difference in purchase costs and utilisation of these electric vans are not very big, compared to diesel vans, leading to the result that the overall total costs of ownership over a period of 4 years are expected to be lower than the total costs of ownership of a diesel van. The cost increase that would occur when purchasing the batteries can be offset through the leasing solution. The lower costs in running electric van operations are due to low energy costs and absence of vehicle registration tax and Congestion Charge. The main differences between the vehicles tested are the load capacity and the battery management. Another difference is the IT monitoring.
The two leading vehicles are the Renault Kangoo and the Nissan e-NV200, but all the other electric vans can be considered as useful complements to the fleet. The reasons for this choice of leading vehicles are the purchase price and purchase conditions of the other electric vans.

3.3.2 Software and IT support for electric vehicle operation monitoring, fleet management and assessment of performance

Fleetcarma software for electric vehicle monitoring was installed on one of the Nissan electric vans and started recording operations from 16 January onwards. The analysis of the data allows first insights in the period 16 Jan - 30 Jun 2015.

Figure 25: Fleetcarma software information overview

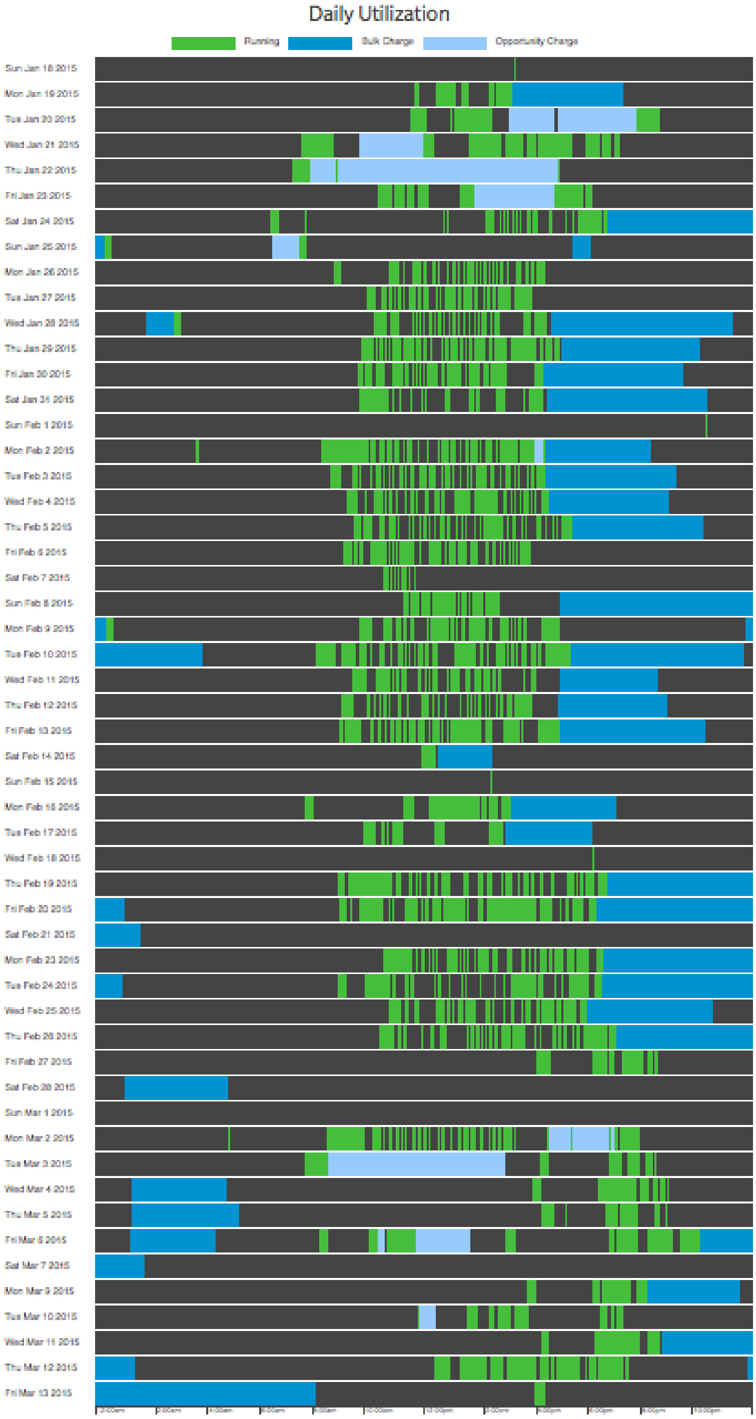


Source: Fleetcarma and Gnewt Cargo, 2015

The onboard software of Nissan enables drivers to see the battery charge and the range that is possible to reach with the current level. The Fleetcarma solution captures this information and transmits it to an online tool with strong analytical and visualisation features. The software gives an overview on performance data. This data demonstrates a strong regularity in electricity use for all trips. A very small variation in overall kWh consumption is observed. This finding was confirmed with the depot counter readings of kWh, which did not show much variation in electricity use.

Another set of Fleetcarma data provides more detail about the daily usage of the vehicle and the battery charging activities (Figure 26). This data has been available on a daily basis for the last few weeks of the project. It shows the regular delivery activity in the day and the recharging almost every night.

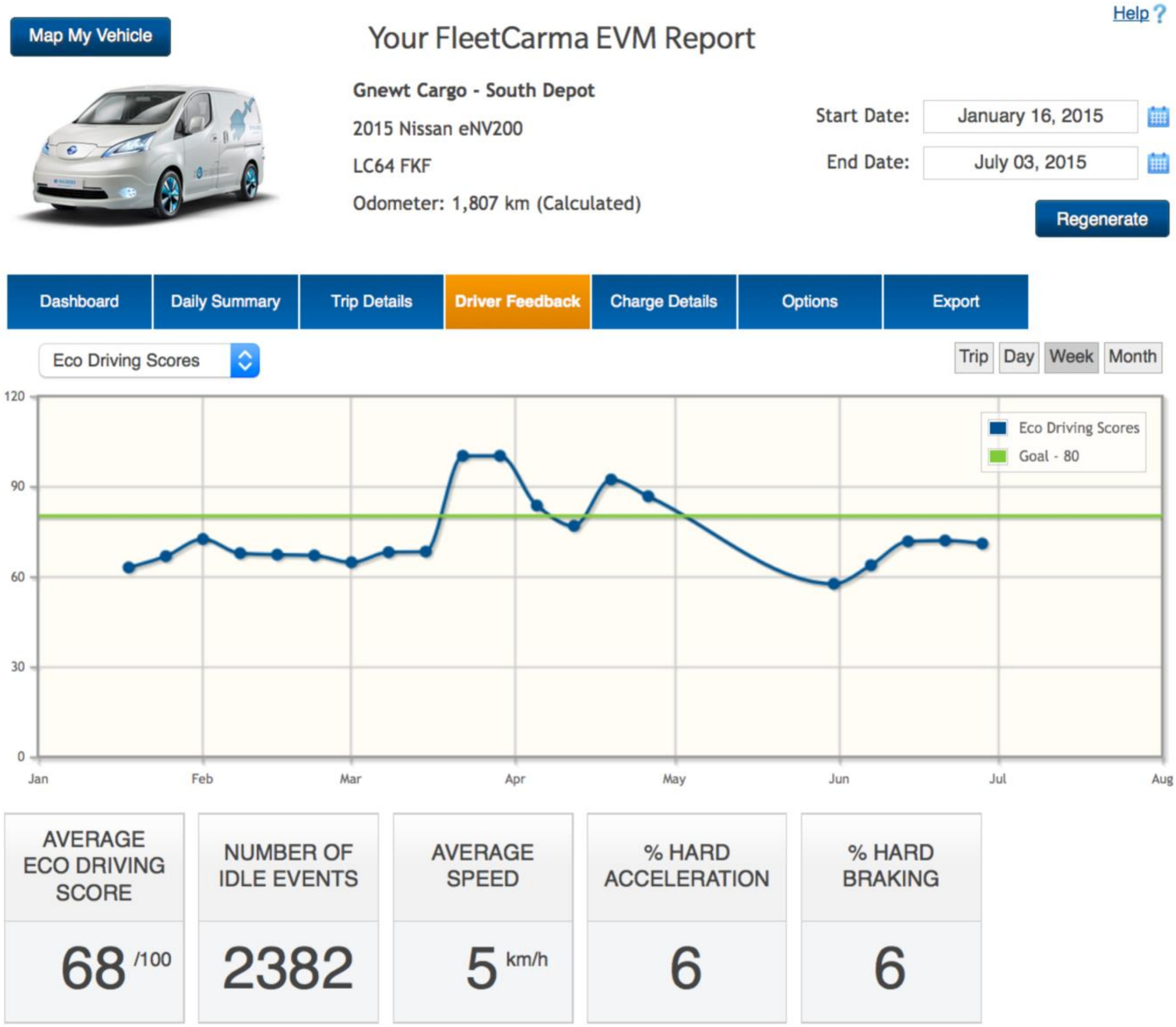
Figure 26: Daily usage of vehicle battery and electric powertrain Jan/Mar 2015



Source: Fleetcarma and Gnewt Cargo, 2015

According to this data, on some days, up to 3 full days could be performed without recharging overnight. The battery capacity therefore permits much more than one full day of work with one single charge. Another element of the Fleetcarma software analysis considers the driver behaviour, especially brake and acceleration, by providing scores. The software thereby enables the assessment of ‘good’ driving habits. As can be seen in Figure 27, the scores vary in the period of data records between January and June 2015, due to changes in drivers and the trips performed.

Figure 27: Assessment of driver behaviour with FleetCarma



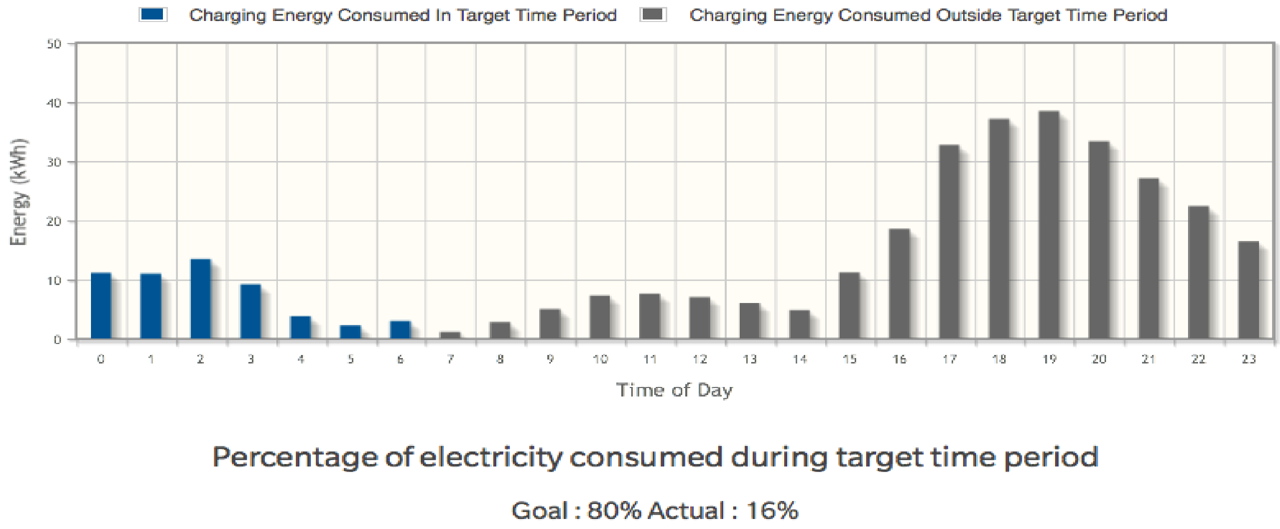
Trip Id	Date	Duration	Trip Distance (km)	Eco Driving Score	Average Speed (km/h)	% Hard Acceleration	% Hard Braking
1.1841	January 18 2015 03:18:01 PM	00:04:03	0.00	100.00	0.00	0	0
2.1841	January 19 2015 11:37:32 AM	00:12:02	0.11	100.00	0.55	0	0
	January 19 2015 12:25:50						

Source: Fleetcarma and Gnewt Cargo, 2015

The Fleetcarma data (Figure 21) confirms the observation made during one day (Table 5), that the average driving speed for the demonstration in London was below 4 mph. For this van running with Fleetcarma, the mean speed in the 6-month period January to June 2015 was even lower, with 5 km/h corresponding to about 3 mph. This very low speed is explicable because the van round is mostly occurring in residential and office buildings area of Central London. Also because the average distance between two delivery stops is generally below 0.5 km, often only about 0.150 km, and the parking operation at kerbside is taking away a substantial part of the driving time.

The Fleetcarma software also provides information about the time of day of charging activity (see Figure 28). This information can be of interest in the case of different energy pricing for off-peak periods. It could also be of use in case of future decentralised energy network management and use of electric batteries for temporary storage capacity. At this moment, Gnewt do not work with different electricity tariff for night and day. But this information will be applied in the future.

Figure 28: Time of day charging energy profile



Source: Fleetcarma and Gnewt Cargo, 2015

The total energy charged over a period of about 5 ½ months is 484 kWh. At a price of £0.10/kWh this represents a total energy cost of £48, about £9 per van per month. Comparing with other data obtained in European project BESTFACT, with vehicles using up to 60 kWh per day, this value for total energy use in parcels delivery in Central London can be considered very low.

3.3.3 Lessons learnt from the Case Study 3

As a concluding remark on Case study 3, focusing on the fleet management and the assessment of different vans, both Renault and Nissan vans provided very good results.

The Fleetcarma software tended to show good data records for these two van makes. Gnewt Cargo intends to continue to purchase these types of vehicles and technology when increasing the fleet for Central London for future operations.

Low energy costs, sufficient distance range and reliability are positive characteristics demonstrated in the electric vehicle trials.

4. Generic studies

Five general studies were added in order to better answer some management questions relevant for the future growth of electric van operations in Central London. How to test innovative technologies? How to improve the data management? How to improve the customer experience? Can the public charging infrastructure be used for urban delivery business? How to improve the cooperation and partnership?

4.1 Generic study 1: Testing innovative technologies and management solutions

The innovative technologies were tested for the new vehicles, for the data capture, and also innovative management solutions were tested in order to better understand the logistics implications of the innovative solutions.
The innovative technologies and management solutions tested are:

- New vehicles: Good results were obtained in combining consolidation and electric freight trials. The vehicles are fully operational and servicing Central London as expected.
- New data capture: The previously existing Gnewt Cargo management system and the new tested Fleetcarma system are linked together. This data enables a much more transparent management of the electric vehicle fleet. GPS data still requires an improved solution.
- Logistics organisation: Growth and peak time can be buffered with the use of an additional depot. The information technology can be used to better manage the use of electric vehicles and to link the information available on-board with the information of the back office.

The Generic study 1 is completed successfully. The innovative methodology developed for the Agile Gnewt Cargo demonstration is confirmed. One of the lessons learnt is that the methodological approach adopted is valid. This includes the merits of the comparison method that includes a before-after approach, which allows the measurement of the impacts after the introduction of the innovation.

Lessons learnt from generic study 1

The main lesson learnt from the first generic study is that the before-after method has been shown to be fully valid and has operated successfully. This methodology was being developed and then fine-tuned for electric vehicle operations and for the comparison of the different depots - the results have been encouraging.

It is expected that this before-after method will allow the assessment of the impacts and benefits of any future technology tested at Gnewt Cargo.

4.2 Generic study 2: Improving data collection management method

When searching for improvement in data collection, the current practice is to be using the existing internal management software system and to complement it with additional information. The current management method includes different data collections and monitoring. There was a need to slightly modify the Gnewt Cargo recording system in place and to complement it with original observations, interview and quantitative records. During the trial, and for the gathering of data on the 'after' situation, some data were collected differently than with the usual internal system.

As of 15 June 2015, the part of the data collection used in the research that is different from a standard internal data collection at Gnewt Cargo consists of using additional data collection spread sheets developed by the University of Westminster. The data collected using this method have been presented in this report. All spread sheets developed were successfully used and the data collection was completed successfully. This method will be reused in the future and the future collection of similar data will allow comparisons over a longer time period, across businesses and across different areas of London.

In addition to this traditional collection of specific trial data, the Fleetcarma IT system has been used to collect data on electric vehicle performance. IT assistance for data collection has proved to be a great benefit for the operational conduct of the trial. At this stage, further implementation of IT solutions (hardware and software) is envisaged. Further testing and checks will be needed.

Lessons learnt from generic study 2

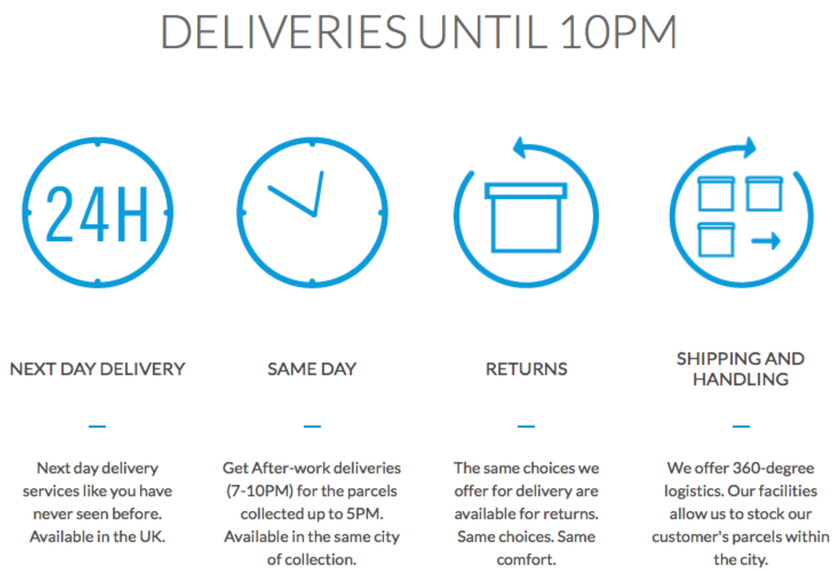
The main lesson learnt in generic study 2 is a new working and management method, with the identification of the best possible combination of efficiency and usefulness of data collection. This is one of the key results of this project for Gnewt Cargo.

In principle, this method can be reused in other trials and survey work in urban freight, in other London Boroughs or in other cities.

4.3 Generic study 3: Business to Consumer business improvement

The software of Emakers is presented below and was implemented at Gnewt Cargo; it is used to improve the communication for clients in London during the delivery process, especially for SMEs.
The main added values of the Emakers business for the end customer are presented in Figure 29.

Figure 29: Emakers business model



Source: Emakers, 2015

The before-after comparison of the eMakers solution is currently showing good results. In June 2015, four clients are serviced with the use of the eMakers solution. These are:

- fashion brands Indetex and Zara
- food consumables B2C brand Farmdrop
- and stationery brand Wiles Greenworld.

Three vans are making deliveries according to the route and timing of deliveries planned with the help of Emakers software, and using the Gnewt handheld device that runs the Emakers software.

Lesson learnt from generic study 3

The Fleetcarma is an innovative solution that is now in place at Gnewt Cargo. It is used mostly for SME clients and retail clients.

It is intended to expand the use of this innovative technology to other clients and to test its potential use for other types of retail delivery operations in the future.

4.4 Generic study 4: Test public access electric charging infrastructure

Many attempts were made to use the public electric charging points in London but not a single one was successful. This generic study did not lead to positive results. At this stage, from the point of view of Gnewt Cargo, the public charging infrastructure is not operational for the urban freight delivery business.
During the trial period, all the charging of the electric vans took place at the Gnewt Cargo depots overnight.

4.5 Generic study 5: Cooperation and partnerships management

The cooperation and partnership with customers such as DX, Hermes and TNT was the basis of the delivery business of Gnewt Cargo in Central London. The cooperation with Crown Estate enabled the development of the new micro-consolidation centres. The method of work to establish and continue the cooperation here is the direct contact with the experts in charge.

Together with the University of Westminster, the partnership consisted of setting up the data collection, monitoring and reporting framework, which was successfully accomplished during the preparation, the trial and implementation stage.

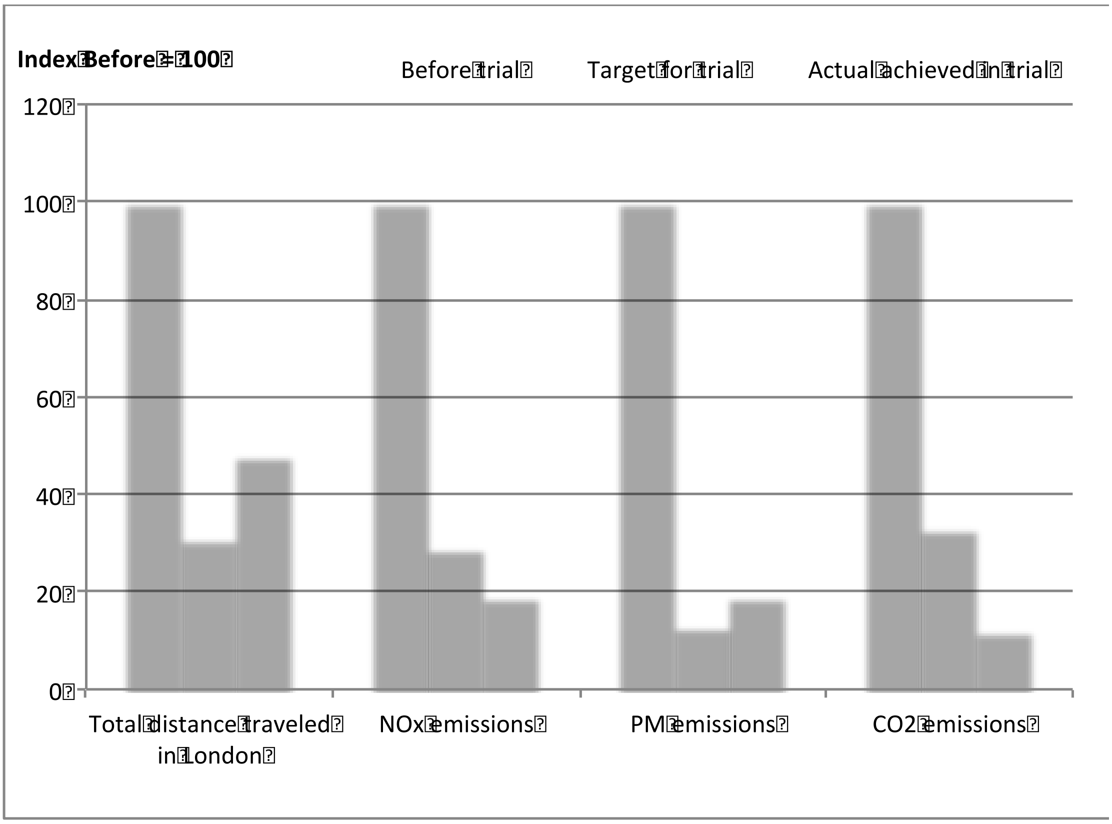
Lessons learnt from Generic study 5

Gnewt Cargo will continue its business with the same approach on partnerships. The demonstrator intends to continue to cooperate and build ever-stronger partnerships.

5. Overview of impacts and targets

The impacts and targets of the demonstrator were monitored in detail in Case Study 2. Initial targets indicators show a very strong reduction. Figure 30 presents the overview on main impacts achieved with the Agile 1 demonstration.

Figure 30: Impacts on Agile targets and key performance indicators



Source: Agile demonstration 2014-2015

The reduction in distance travelled of 52% leads to a reduction in traffic and can thereby have a direct beneficial impact on road congestion and traffic accidents. The reduction in empty vehicle distance is 65%. The reduction in air pollutants such as NO_x and PM, is 81% (see Table 21 and Figure 30). The reduction in CO_2 emission is 88%.

Table 21 shows the initial target foreseen at the inception of the demonstration, in mid-2014.
It shows also the proportion of the targets that was achieved during the project.

Table 21: Key indicators, targets, achievements and proportion of targets achieved

	Before trial	Target for trial	Actual achieved in trial	Proportion of target actually achieved in trial
Reduction in km travelled	100	31	48	75%
Reduction in NOx	100	29	19	114%
Reduction in PM	100	13	19	93%
Reduction in CO2	100	33	12	131%

Source: Agile demonstration 2014-2015

Three additional Key Performance Indicators were achieved

- Reduction in the main axis distance: 74%
- Reduction in empty vehicle distance: 65%
- Increase in staff employed: 7%

As documented in the monitoring Data Report M7, only one of the indicators has increased during the trial, this is a 7% increase in the number of staff needed to achieve the same delivery performance in terms of parcels delivered per day per driver. The joint operation of Gnewt Cargo and its clients Hermes and TNT has required more staff because of the trucks making their trips between depots at night.

The achievements of the demonstration project are covering mostly the initial goals of the Agile Urban Logistics programme of the GLA. This report shows, according the programme objectives, to the business community and public sector decision makers, the benefits that result from using clean vans and consolidation centres.

6. Concluding remarks

The Agile Gnewt Cargo demonstration project was successfully implemented and carried out. This report demonstrated what are the benefits for decision makers in industry and public sector of using clean vehicles and central consolidation centres. The new depot operations were successfully set-up and run for the peak delivery period at the end of 2014 to cope with the Christmas demand (Case Study 1). As this trial of the use of a depot for the peak Christmas period was a success in terms of operating results, managerial organisation, and networking with business partners, it is expected that this additional depot operation will reopen for Christmas peak period in 2015.

The new electric vans were successfully introduced into the Gnewt Cargo operations and are expected to continue operating on a daily basis, as part of the delivery vehicle fleet (Case Study 3). The data necessary to monitor and assess the trial was successfully collected before and after the trial start, to allow robust quantitative results (Case Study 2). This evidence has been analysed and reported on in this document. The methodology devised for and implemented in the Agile demonstration trial has therefore been validated.

The total distance travelled in the logistics system operated by Gnewt Cargo for deliveries from a suburban depot via micro-consolidation centres to receivers in central London has been reduced by 52%, compared to the previous logistics service provider system operated from Enfield in outer London. Other negative external impacts such as contributions to traffic congestion and accidents would therefore be expected to also be reduced as a result of adopting such a logistics system.

On major roads, and during peak traffic time, the distance reduction was 87% in January 2015 and 78% in April-May 2015 measurements periods compared with the situation before the trial. In addition, night traffic has replaced peak-time traffic. Vehicle empty-running distance has also been reduced by 65%. Air pollution and CO_2 were reduced by 81% and 88% respectively. The energy price was 87% lower for electric vans than for diesel vans.

The wider public traffic and environmental benefits for London are therefore substantial. The demonstrated solutions are also scalable. The solutions tested are profitable and the Gnewt Cargo logistics business based on the use of micro-consolidation centres and electric vehicles is continuing to grow from year to year. The operations grew at a rate of 50% between the business years 2012-13 and 2013-14, and at a rate of about 150% between 2013-14 and 2014-15. There are good reasons to assume that there will be further strong growth in the years 2015 and 2016.

Legacy

The wider potential impacts of the trial for London could not be assessed quantitatively. In order to do so, an additional clear data collection effort including other operators and potential future clients would be needed. For now, a fleet of 100 electric vehicles is very small compared to the whole of Central London and a daily fleet of more than 250,000 goods vehicles (London Freight Data report 2014). As the demonstration is now showing, it is too small to make a difference on total London air pollution or total traffic. But it can be scaled up in the future.

For the legacy of the Agile project, the growth potential of this type of clean delivery business can be guessed, because of few other existing positive experiences, good practices and success stories, such as the Camden Consolidation centre run by the Borough of Camden, and the Regent Street Consolidation Centre run by Clipper Logistics. When compared to these and to other European similar clean delivery businesses, the lessons learnt in the Agile Gnewt Cargo project can be considered representative and applicable elsewhere.

Therefore, this project represents a clear advancement in the knowledge on clean urban logistics and its business case, and there is no reason why the solutions presented here should not be transferred to, and replicated in other London Boroughs or other businesses. As a legacy, the effects of introducing the solution on the market are clearly beneficial for wider society both for the environment and business efficiency and profitability. The data collected and analysed provides evidence that the operational solution trialled can be replicated, new Central London depots can be opened, and new clean freight vehicles can be purchased and used successfully in London.
In order to scale up the solution demonstrated in this project, several possibilities seem feasible.

The first would be the economic growth of the current business through acquisition and contracting of new large-scale clients in London, the opening of new depots and the purchase of additional clean vehicles. The knowledge on how to do this is now available from this trial and is replicable. The second solution would be to apply the same solution in another business such as food deliveries or construction. Ideally, the successful transfer of this solution from one business sector to another should be trialled and evaluated so that it can be robustly studied and the evidence and the knowledge about it become publicly available.

The third solution would be to transfer the solution to another area of London, to open a new depot there, to obtain a contract with a new client, and to purchase a clean vehicle fleet. Again this transfer of good practice would benefit from a trial phase and from a quantitative evaluation. Gnewt's business model and infrastructure was tailored towards this type of operating model from the company's inception. It is this fact that has enabled the demonstrator to achieve the environmental savings and operational efficiency that has proved a barrier to other logistics companies. The concept of smaller, central consolidation centres and a fully 100% electric fleet is integral to the success of Gnewt and the ability to provide viable research results to GLA.

Constraints and challenges experienced during the project

Technical barriers - There are limitations to the approach trialled in this project and the ability to deliver the legacy above. The electric freight business is not currently suitable for heavy loads transported by Heavy Goods Vehicle. For pallets or heavy goods deliveries to receivers of more than one tonne per day, trials with other alternative fuels are likely to currently prove more successful such as the experience of Howard Tenens with biogas as fuel and gas motor as main engine. This has not been tested in London yet.

The 100% full-electric freight business is also not suitable for long distance transport and the current range of approximately 60 miles per day is fairly limited, but this is considered sufficient for parcels deliveries. Due to the range limitation, a high density of customers is required. A transport business that would require long distances between customers is not suitable for full-electric vans at this time.

Charging infrastructure – one test the project was unable to make any headway was about the London charging infrastructure. Of the approximate 1600 charge points in the Capital, Gnewt found that less than half of them were functional. Of the fast charging points that were/are of particular interest for fleet operators that need this capability to ensure the viability of electric vehicles, there were virtually none in operation within the Central London area.

Vehicle legislation – some of the vehicles we hoped to test as part of this project were not made available for a live trial, due to the inability to get clarification on how they were to be classified. Vehicle variants, especially in the electric vehicle market, is getting ever more diverse, but current

legislation sometimes struggles to categorise these alternative means of transportation which results in stemming the progress of these more environmentally led alternatives.
There is also out-dated legislation we discovered during this trial that is not fit for purpose. For example, commercial electric vans older than 3 years are exempt from MOT testing due to rules created around milk floats. Although the vehicles have considerably less mechanical parts and less wear and tear, fundamentals such as tyre and brake wear are equally prevalent but not compulsory to be checked.

Gnewt reflections and thoughts

In our experience and from what we have learnt throughout this project, there are a number of areas whereby local or governmental policy changes would help drastically increase both the uptake in EVs but also allow a more viable scalability for companies such as Gnewt and the concepts that were analysed as part of this report.

PCNs – parking tickets are a significant cost to businesses like Gnewt. In many cases, tickets are issued not because drivers have parked illegally, but simply because a rule is given to Parking Attendants that if no continuous activity is seen for a period of 5 minutes, then a ticket can be issued despite the driver not exceeding his 20 or 40 minute allowance. Drivers have reported that their productivity and efficiency would be greatly increased (and consequently result in considerably less journeys travelled) if they were not required to relocate their vehicle so many times a day just to avoid a ticket issue.

Table 5 shows the observation on PCN impact on a typical working day. Gnewt's success rate on appealed tickets is currently over 90% demonstrating that many tickets have been unnecessarily issued at a cost both to the businesses and councils alike.
So there are two points that could be avoided through an improved PCN management in future:

- The impacts of the charges for business and councils should be reduced through changes in application rules
- The behaviour change of drivers would lead to an improved traffic and more delivery efficiency if exempted from the need to remove the vehicle to avoid PCNs.

Charging – as previously mentioned, the London charging infrastructure, were it working to its fullest, would be a huge benefit to the uptake of EVs. Currently for companies like Gnewt, such is the uncertainty and unreliability of the network, and despite millions of miles travelled by EV in the last 5 years, not one Gnewt van has ever used the public charging infrastructure.

Central locations – In order for the model that has been demonstrated in this project to work, central locations are vital. As the battery technology continues to improve, the need for the very central locations, that the like of Gnewt utilises, will reduce, as the vans will be able to travel further. However, with all the new development now happening in the City and the wider London area, very little consideration has historically been placed on how these new office blocks and residential dwellings are to be serviced by the road network.

This project utilised a Crown Estate property that had under-utilised space to great effect and the big land owners in London will certainly have similar areas that could benefit from this alternative use. We believe that areas of new development should be safeguarded and incorporated in the planning to achieve the scalability and success that this project has demonstrated.