



The road to reducing commercial vehicle emissions

Exploring the technical barriers to uptake of
alternatively fuelled commercial vehicles

A study commissioned by Transport for London

Executive Summary

Background and objectives

Transport for London has ambitious targets to meet over the next 10-15 years, both in terms of air quality improvement, and in terms of decarbonisation of transport. Commercial vehicles, including light goods vehicles (LGVs) and heavy goods vehicles (HGVs) account for 16% of transport CO₂ emissions and 17% of transport-related nitrogen oxides in London¹, and TfL is taking specific measures to reduce emissions from this sector.

The introduction of the Ultra Low Emission Zone in 2020 will require all HGVs and diesel LGVs to meet Euro VI / 6 standards (or pay a daily charge) to operate in this zone. This is expected to considerably reduce the NO_x and particulate matter (PM) contributions from commercial vehicles, but further measures will be needed to reduce air pollution to safe levels that achieve compliance with national air quality objectives. LoCITY was launched in 2016 with the objective of further reducing emissions from commercial vehicles, by helping fleets to go beyond the ULEZ requirements. LoCITY will make it easier for operators to invest in low emission commercial vehicles by working to improving the supply of vehicles and infrastructure, identifying locations for refuelling and recharging infrastructure, and developing new procurement standards that will stimulate accelerated uptake of alternatively fuelled vehicles².

Transport for London has commissioned Element Energy to provide a detailed account of the technical (i.e. non-cost related) barriers to wider adoption of alternatively fuelled commercial vehicles, and to identify opportunities for a range of measures that could be introduced to incentivise their increased uptake. The results of this study will inform LoCITY and enable it to develop specific outputs that will stimulate uptake of alternatively fuelled vehicles (AFVs). The recommendations will support LoCITY in taking forward and prioritising measures to address the barriers to uptake of AFVs, and help fleets, manufacturers, and infrastructure providers maximise opportunities to adopt these technologies.

Scope and approach

The alternative energy vectors that have been considered are (bio)methane (including CNG and LNG), electricity, hydrogen and liquefied petroleum gas (LPG). This study has explored the technical barriers to AFV uptake in London, and the opportunities to address these barriers, through:

- An extensive review of previous research;

¹ TfL, *Transport Emissions Roadmap, Cleaner transport for a cleaner London*, September 2014

² i.e. vehicles using fuels other than petrol or diesel, and which provide reduced emissions levels.

- Interviews with 15 fleet operators with vehicles operating in and around London (including HGV and LGV fleets); 6 infrastructure providers (hydrogen, rapid charging points, natural gas, LPG); 7 vehicle manufacturers (covering all the alternative powertrain technologies in scope);
- A workshop with policymakers to test feasibility of suggested actions

Barriers to uptake of alternatively fuelled vehicles in London

The key barriers identified in this study (beyond vehicle cost premiums) are summarised in Figure 1. The arrows show how the barriers for each stakeholder contribute to barriers for the other stakeholders.

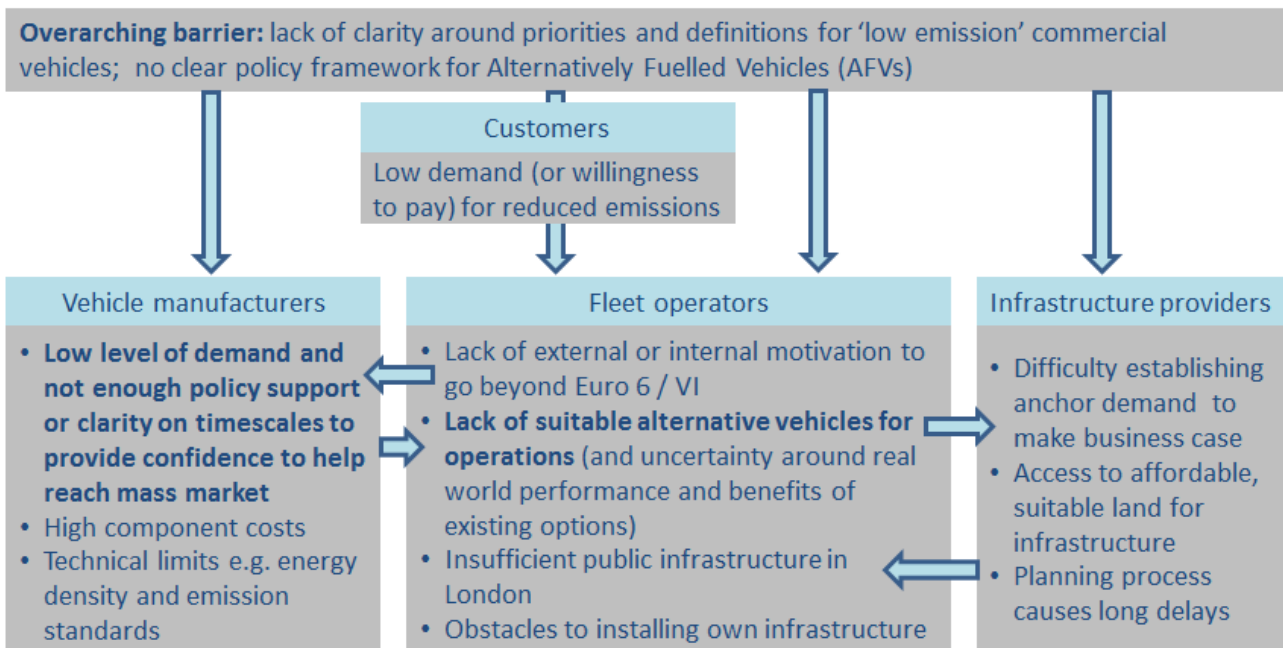


Figure 1 Barriers to uptake of AFVs in London

Major barriers affecting all stakeholders

1. *Lack of clarity around priorities and definitions for “low emission” commercial vehicles*
2. *No clear, long term policy framework for alternatively fuelled commercial vehicles*

These factors impact all stakeholders in the commercial vehicle sector to some extent. Although there have been various funding schemes available to support fleets in adopting AFVs in recent years, there is no clear policy framework for alternatively fuelled commercial vehicles. This reflects the fact that, beyond Euro 6 / VI standards, there is no definition of what constitutes “low-emission” or “ultra-low emission” for commercial vehicles that is consistent at local and national level. There is also no clear national

picture of the priorities and expected timescales for reduction of air quality related pollutants (i.e. NO_x and PM) beyond Euro 6 / VI, or for reduction of carbon emissions from commercial vehicles. To date, uncertainty around the benefits of HGV technologies such as gas have delayed policy commitments of this nature. Evidence emerging from ongoing work supported by DfT and LoCITY (e.g. the DfT-LowCVP HGV Methane Strategy, the LowCVP HGV Accreditation Scheme and the DfT-LowCVP Gas Truck Trials, including the LoCITY van extension) will support policy development and inform possible local measures.

The key barriers for different stakeholder groups are summarised below.

Barriers for fleet operators

1. Lack of suitable alternatively fuelled vehicles

This was the most frequently identified barrier by the fleets interviewed in this study. It manifests in three ways:

- No alternative fuel options in some vehicle classes (e.g. refuse collection vehicles above 26t)
- No alternative fuel / low emission options with sufficient range, payload or power capabilities (e.g. van fleets requiring ranges and/or payloads beyond that provided by current electric van offerings; haulage companies requiring higher horse power than that provided for the available gas trucks)
- Limited volumes or long lead times on some options, such as converted or bespoke vehicles and the newest gas or electric truck models.

2. Insufficient public infrastructure in London

- An insufficient network of CNG, LNG and hydrogen refuelling stations, and of rapid charging points, was reported to be a significant barrier to the adoption of the corresponding vehicle technologies. Similarly, there is limited information on the locations of LPG stations that can be used by HGVs (i.e. without a low canopy).
- Based on the interviews, fleets already operating CNG or LNG HGVs in the UK are more likely to operate these vehicles outside London, rather than in and around the city. This was partly due to the limited gas infrastructure in and around London, and partly due to the third identified barrier (see below).

3. Uncertainty around vehicle performance and whole life costs for London applications

- Operators doing local deliveries or providing utility services in London require considerable flexibility in driving range and payload to account for variations in traffic and terrain in different areas. Also, the effect of congestion means that routes are likely to be slightly slower and more stop-start in London than on routes in other parts of the country, even for long-distance trips starting or ending in the city.
- These factors mean that fleets do not have a high level of confidence that the performance and whole life cost data from manufacturers or from existing case studies

will reflect their London operations, and therefore London may not be the priority area for deployment of AFVs. This is particularly relevant for gas vehicles.

4. *Lack of motivation (internally or from customers) to go beyond Euro VI / 6 for commercial vehicles (especially HGVs) and (for those that are motivated), desire for guidance on which technologies will be supported by local and national government*
 - This relates to the absence of clear definitions and priorities for low emission commercial vehicles, and appropriate national policy incentives. For example, London's Ultra Low Emission Zone (ULEZ) will impose a charge on diesel vehicles not meeting Euro 6 / VI regulations, but there are no proposed measures to support operators going beyond these requirements.

Barriers for vehicle manufacturers

1. *Low demand and not enough policy support or clarity on timescales to provide confidence that technologies will be supported through to mass markets*
 - While many of the manufacturers interviewed have plans to increase their offer of AFVs in the UK (including gas, electric and hydrogen vehicles) the limited nature of current policy incentives and timescales for such incentives was cited multiple times as the primary barrier to faster product development and greater production volumes.
2. *High component costs (particularly for fuel cell, hydrogen tanks and latest battery technologies)*
3. *Current technology limits range and payload (e.g. energy density of batteries to date is not high enough to allow long driving ranges while maintaining payload, hydrogen tanks are only available in certain size and shapes)*

Barriers for infrastructure providers

1. *Difficulty establishing anchor demand to make business case*
 - Partly due to a lack of information on where and when fleets will adopt AFVs. The higher level issue behind this is that, like vehicle manufacturers, infrastructure providers are subject to uncertainty around the long term market development.
2. *Difficulty expanding the limited infrastructure network due to limited availability and higher cost of land in and around London*
3. *Length of planning permission process*

There are also a range of barriers to public and depot infrastructure deployment specific to each fuel type (see page 27 for full details).

The lack of a clear policy framework for commercial vehicle emissions (beyond the move to Euro 6 / VI) is a major contributing factor behind the barriers outlined above. Options for

fleets seeking to adopt AFVs are limited by the available vehicle options, which is in turn partly due to a lack of long term policy commitment to financially support the developing market. Uncertainty around how the market will develop also contributes to the challenge of making public infrastructure financially viable, thus perpetuating the “limited infrastructure” barrier for fleets.

Recommendations to accelerate uptake of alternatively fuelled vehicles

High level recommendations for each set of stakeholders to address the barriers to AFV uptake are set out below.

Recommendations for policymakers (see p32 & p35 for full details)

National policymakers should aim to develop a consistent policy framework for commercial vehicle emissions. This process should include the following objectives:

- Define targets and timescales for commercial vehicle emissions reductions going beyond Euro 6 / VI standards;
- Define “low / ultra low emission” in a way that is applicable to a range of technologies;
- Implement policy at national and local level that is consistent and provides financial and non-financial incentives for use of AFVs that go beyond Euro 6 / VI standards.

Recommendations for fleet operators, vehicle manufacturers and infrastructure providers (see p40 for full details)

- Industry stakeholders should engage with policymakers to help define targets, timescales and measures that will support market development and reduce emissions
- Fleet operators and infrastructure providers should work together to align timings and locations of AFV adoption and infrastructure deployment. Where possible, vehicle manufacturers should identify spatial clusters of customers acquiring AFVs to help facilitate this process.
- Fleet operators and infrastructure providers should engage with and participate in trials of innovative technologies to demonstrate real-world applicability and provide evidence of cost and emissions savings
- Information sharing: fleet operators should share information on AFV performance and costs in specific applications; infrastructure providers should communicate fuel pricing; vehicle providers should advertise emissions savings in line with national definitions of low emission and ultra low emission vehicles.

LoCITY has already stimulated progress on information sharing: CNG Fuels began publishing a CNG price index in April 2016, following a discussion on this during an interview for this study.

Recommendations for LoCITY (see p38 for full details)

LoCITY should:

- Continue to act as a link between government and industry, supporting policy development by aggregating industry input and facilitating information exchanges

- Aim to support industry actions highlighted above by facilitating workshops and trials
- Work to provide a centralised resource of trusted, impartial information for fleets and other stakeholders, including: details of and case studies for different vehicle technology options; infrastructure locations; local regulations and incentives (and where possible, notice in advance of measures that support emissions reductions beyond Euro 6 / VI standards), and details of related national policy. This should be primarily applicable to fleets operating within London but also relevant to those operating nationally and as such, should endeavour to include relevant input from local authorities outside London (e.g. on details of Clean Air Zones).

Figure 2 summarises the key recommended actions and suggested responsibilities for three broad themes: policy framework, collaboration and information, and addressing specific barriers for vehicle and infrastructure deployment. Actions are not all expected to be implemented in the short term. For example, defining priorities, targets and timescales for commercial vehicle emissions reduction will take several months, whereas updating national policies and guidance could take a year or more. The figure below provides indicative timescales. Many of the actions identified for LoCITY are already underway or planned, indicating that this programme is well positioned to support the uptake of AFVs.

		Stakeholders should:	Short term	Mid term	Long term
Policy framework	National government	Define priorities, targets and timescales for emissions reduction from commercial vehicles	█		
		Update national policies and Corporate Social Responsibility guidance		█	█
	Local authorities	Update London-specific policies		█	
	Industry	Help policymakers to define targets, timescales, and measures;	█		
Advertise emissions benefits in line with national definitions				█	
Collaboration and information	OLEV LoCITY	Create a centralised website with resources for UK fleets and other stakeholders (for all AFV technologies)	█		
	LoCITY	Facilitate trials and workshops, acting as the link between industry and policymakers		█	
	Industry	Share information on AFV performance and costs in specific applications; communicate fuel pricing	█	█	█
Addressing specific barriers for vehicle and infrastructure deployment	OLEV	Liaise with EU legislators to facilitate public procurement of AFVs			█
	DCLG, national government	Issue alternative refuelling station guidance for planning authorities		█	
	Local authorities	Identify and highlight suitable public / private land for infrastructure	█	█	█
	OLEV LoCITY	Support the creation of a unified map for infrastructure locations and availability			█
	Industry	Seek to align infrastructure deployment with vehicle sales timing and locations; trial innovative vehicle and infrastructure technologies	█	█	█
	Industry	Provide a platform for 3 rd parties to suggest solutions to network connection & upgrade costs incurred by fleets for depot charging / refuelling	█	█	█

Figure 2 Key recommendations to achieve increased AFV uptake in London

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Acronyms

AFV	Alternatively fuelled vehicles
BOLG	London Councils London Freight Borough Officer Liaison group
CCC	Committee on Climate Change
CNG	Compressed natural gas
CO ₂	Carbon dioxide
CSR	Corporate social responsibility
DECC	Department of energy and climate change
DEFRA	Department for environment, food and rural affairs
DfT	Department for transport
EV	Electric vehicle
FTA	Freight Transport Association
GLA	Greater London Authority
GVW	Gross vehicle weight
HGV	Heavy goods vehicle
LGV	Light goods vehicle
LNG	Liquefied natural gas
LowCVP	Low Carbon Vehicle Partnership
LPG	Liquefied petroleum gas
N1	Refers to goods vehicles up to 3.5t GVW
N2	Refers to goods vehicles over 3.5t GVW and up to 12t GVW
N3	Refers to goods vehicles over 12t GVW
NO _x	Nitrogen oxides
OEM	Original equipment manufacturer
OLEV	Office for low emission vehicles
PHEV	Plug-in hybrid electric vehicle
E-REV	Extended range electric vehicle
RHA	Road Haulage Associate
SME	Small and medium-sized enterprise
TfL	Transport for London
ULEZ	Ultra low emission zone
VCA	Vehicle Certification Agency
WTW	Well to wheel

Introduction

Background and objectives

London's air quality issues and decarbonisation targets are driving the move towards alternatively fuelled vehicles (AFVs) in London. Poor air quality is second only to smoking as a public health problem. With nearly 9,500 people dying early each year due to air pollution in London, Transport for London (TfL) and the Greater London Authority (GLA) are engaged in many projects and programmes to improve air quality and reduce emissions. The Ultra Low Emission Vehicle (ULEV) Delivery Plan outlines TfL's current and planned activities towards increasing the uptake of ULEVs. This includes an action to increase their uptake in freight and fleet organisations. Commercial vehicles, including light goods vehicles (LGVs) and heavy goods vehicles (HGVs) account for 16% of transport CO₂ emissions and 17% of transport-related nitrogen oxides (NOx) in London³, and therefore TfL is taking specific measures to reduce emissions from this segment.

The introduction of the Ultra Low Emission Zone in 2020 will require all HGVs and diesel LGVs to meet the Euro VI and Euro 6 standards respectively or be subject to an additional daily charge of £100 for HGVs or £12.50 for vans to enter the zone. This is expected to considerably reduce the NOx and PM contributions from commercial vehicles, but further measures will be needed to reduce air pollution to safe levels that achieve compliance with national air quality objectives.

LoCITY was launched in 2016 with the objective of further reducing emissions from commercial vehicles. LoCITY will complement the ULEZ by helping fleets comply with the new standards and go beyond them to minimise their environmental impact.

LoCITY is an industry led programme that aims to support public and private fleets in upgrading to cleaner vehicles and alternative fuels, improve London's air quality, and help meet London's targets on reducing carbon dioxide emissions. This will be achieved by improving the supply of low emission commercial vehicles and infrastructure, making it easier for operators to invest in the technology, and by developing new procurement standards that will stimulate accelerated uptake of alternatively fuelled vehicles (AFVs).

Element Energy has been commissioned by TfL to conduct a study to inform the LoCITY programme and enable the development of specific outputs to stimulate accelerated uptake of AFVs. The key objectives of the study are as follows:

- Understand the constraints and barriers affecting fleet and freight operators, vehicle manufacturers and refuelling/recharging infrastructure providers, with a particular focus on the technical barriers.

³ TfL, *Transport Emissions Roadmap, Cleaner transport for a cleaner London*, September 2014

- Provide clear and actionable recommendations to mitigate/address barriers to adoption and therefore accelerate the uptake of AFVs.

Scope and approach

Scope

This study explores the barriers to AFV uptake in London, for operators of commercial vehicles, including HGVs (defined as vehicles with a gross vehicle weight of over 3.5 tonnes) and LGVs or “vans” (gross vehicle weight of up to 3.5 tonnes).

The following alternative vehicle technologies were included in the scope of this study:

- Gas - Compressed or Liquid Natural Gas (CNG/LNG) [including biomethane]
- Liquefied Petroleum Gas (LPG)
- Dual fuel hydrogen diesel (H₂ dual fuel)
- Battery Electric Vehicles (BEV)
- Extended Range Electric Vehicles (E-REV) or Plug in Hybrid (PHEV)
- Hydrogen Fuel Cell Extended Range Electric Vehicles (FC E-REV)

This covers a range of alternative fuel technologies currently on the market for commercial vehicles. Biodiesel (including used cooking oil) and synthetic fuels which can be used as “drop-in” solutions or blended with diesel are not included in the study, as they have not been shown to provide significant reductions to NO_x or PM emissions compared to diesel⁴.

Approach

The barriers to AFV uptake in London, and the opportunities to address these barriers were explored through an extensive review of previous research, interviews with 28 industry stakeholders, and consultation with relevant policymakers. The overall approach is summarised in Figure 3.

A review of the existing body of research explored the barriers to AFV uptake in the UK freight sector. This review identified barriers from the perspective of end users, vehicle manufacturers and infrastructure providers, and examined how these barriers are projected to decrease on the basis of planned vehicle supply, and expected technical improvements. In addition, the review explored UK policies, initiatives, and/or products that were successfully deployed or proposed to mitigate these barriers.

The evidence gathered in the review was used to derive questions for industry stakeholders (operators, vehicle manufacturers, infrastructure providers and policy

⁴ E.g. see p19 of The Low Emission Van Guide, LowCVP & Cenex, June 2015

makers), with the intention of revealing details beyond the well documented barriers to uptake and the specificities of London operations.

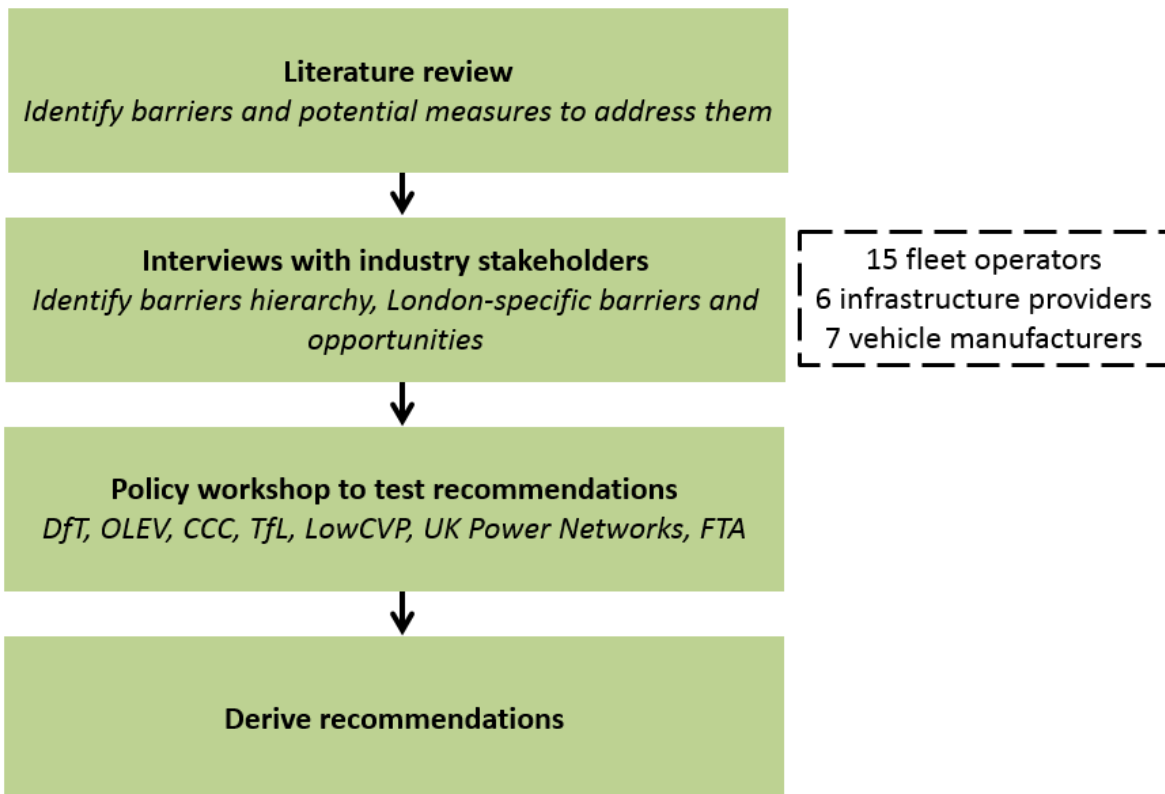


Figure 3 Summary of approach

In parallel to the literature review, interviews were arranged with 15 operators of fleets operating in London (including HGV and LGV fleets); 6 infrastructure providers (for hydrogen, CNG, LNG, and LPG refuelling, and rapid charging points); and 7 vehicle manufacturers (covering all the alternative powertrain technologies in scope). The organisations of the interviewees are listed below.

Fleet operators	
British Gas	O'Donovan Waste Disposal Ltd
CitySprint	Royal Mail
Clear Channel UK	Sainsbury's
Commercial Group	UPS
DHL International (UK) Ltd	Veolia UK
Howard Tenens	Wincanton Group
John Lewis Partnership	Z-Tech Control Systems Ltd
Marks and Spencer	

Infrastructure providers	
CNG Fuels	ITM Power
Calor Gas Limited (LNG business unit)	Siemens plc
Calor Gas Limited (LPG business unit)	Zapinamo Ltd

Vehicle manufacturers	
Iveco	Symbio FCell
Mercury Fuel Systems Ltd	Tevva Motors Ltd
Nissan Motor (GB) Ltd	UlemCo Ltd
Scania (GB) Ltd	

Metrics such as business sector, fleet size, and refuelling habits were used to select a diverse sample of commercial fleets and prioritise interviews that would altogether cover fleets with a range of experiences of AFV technology. The majority of fleet operators selected for interview already had experience of AFVs and were therefore expected to be more knowledgeable about barriers preventing further adoption of AFVs.

Background material was provided in advance, to maximise participation and make the interviews as productive as possible. Questions were informed by the literature review and were tailored by stakeholder type, with the primary aim of identifying the key barriers to AFV uptake, specifically in London. Potential policy measures that could address these barriers were also discussed, with a view to identifying the measures that were most likely to be effective. The interview results, combined with the literature review, informed an analysis of the key barriers for AFV adoption in London and the opportunities to address these barriers.

In addition to the 28 interviews conducted with stakeholders, policy makers and policy-related stakeholders were consulted on the emerging opportunities and recommendations via a policy workshop with representatives from the Office of Low Emission Vehicles (OLEV), the Department for Transport (DfT), the Low Carbon Vehicle Partnership (LowCVP), the Committee on Climate Change, the Freight Transport Association, UK Power Networks and several TfL teams. This workshop investigated the feasibility and conditions for the implementation of the emerging recommendations and provided a comprehensive insight into the latest developments in the transport policy landscape, informing the final recommendations provided in this report.

Barriers and opportunities

Existing research

Figure 1 summarises the main barriers to AFV uptake that have been identified in previous research. As indicated in Figure 4, this study has not explored the cost-related barriers in detail, as they are already well understood.

Themes	Common barriers to alternative fuel vehicle adoption	
High costs compared to diesel vehicles	<ul style="list-style-type: none"> • Business case not acceptable due to: <ul style="list-style-type: none"> – Vehicle costs / capabilities / uncertainty around residual value – Fuel / infrastructure costs 	<p>Cost barriers not explored in detail in this study</p>
Vehicle supply & capabilities	<ul style="list-style-type: none"> • No suitable alternatives available for specific segment • Range or payload constraints would impose significant operational changes • Lack of clarity on variation in capabilities for different usage patterns • After-sales support services (e.g. repairs) prohibitively lengthy 	
Constraints for depot-based infrastructure	<ul style="list-style-type: none"> • Difficulty obtaining permission to install charging/refuelling infrastructure (compared to current refuelling facilities) • Logistics of refuelling/recharging are prohibitive beyond trial status 	
Public and semi-public refuelling infrastructure	<ul style="list-style-type: none"> • Insufficient refuelling/recharging infrastructure nearby • Existing infrastructure is not reliable (or incompatible) • Use of shared refuelling facilities is prohibitive due to tight refuelling timescales 	
Internal and external policy	<ul style="list-style-type: none"> • No internal policy for adopting lower emission vehicles • Difficulty assessing environmental benefits of technology options • Lack of clarity around priorities for air quality and CO₂ emissions 	

Figure 4 Common barriers to adoption of alternatively fuelled vehicles

Through interviews with fleet operators, vehicle manufacturers, and infrastructure providers, the specific non-cost barriers and opportunities for adoption of alternative fuel commercial vehicles in London have been explored. These interviews revealed three broad topics, which reflect some of the themes in Figure 4, and are discussed in detail in the following sections.

National, local and fleet emissions strategies

Table 1 summarises the level of environmental commitment demonstrated by the fleets interviewed. As shown in the table, the majority of fleets surveyed were in group 2 or group 3, with internal objectives to reduce fleet emissions and adopt alternative fuel technologies. However, a clear theme that emerged from fleet interviews was the perceived lack of clarity around the regulatory approach to commercial vehicle emissions, in terms of specific reduction targets and technology preferences, and in terms of priorities around air quality and CO₂ emissions. This presents a challenge for operators to identify how to future-proof their fleet strategies.

Fleet operators have no clear view of the local or national expectations for commercial vehicles, beyond the transition to Euro VI / 6 (especially in the case of HGVs). For those not motivated by environmental drivers (either internally or from customers), this means that there is no strong driver for consideration of alternative fuel technologies (which often have an upfront price premium⁵). For those with strong environmental motivations, there is support for an incentive to go beyond Euro VI / 6, particularly in London. In some cases, fleets also worry about “making the wrong choice”, i.e. choose a technology that will turn out to be outside the future government’s priorities.

Addressing this lack of clarity would help fleet operators across the spectrum to identify opportunities and appropriate timescales for adoption of alternative fuel vehicles, enabling them to make the strategic decisions necessary ahead of time. Considering that the share of “innovative” fleets with strong environmental motivations is lower in real world than in the interview sample (which specifically targeted operators with experience of using AFVs), a clear regulatory drive for emissions reductions will be needed if significant take up of alternative fuel vehicles is to be achieved.

Table 1 Groups of fleets by increasing environmental commitment

Groups of fleets by increasing environmental commitment		
1 – Not affected by environmental drivers, exclusively cost driven	2 – Innovative values, limited implementation	3 – Strong environmental motivations, significant experience of alternative fuels
<20% of fleets interviewed	>80% of fleets interviewed. Most of these fleets were either large corporate organisations with strong internal emissions reductions targets, or fleets with such organisations as their customers, as opposed to serving private customers or small local businesses.	
Typically don’t have	Generally have a CO ₂ or	Have internal CO ₂ targets and

⁵ Some fleets purchase alternative fuel technologies because they can achieve running cost savings that make up for the premium purchase price, but this is strongly dependent on the particular usage patterns and payback period requirements of individual fleets.

CO ₂ or energy reduction targets. No or low awareness of air quality issues.	energy reduction target and might informally consider air quality aspects but low 'pull' from customers for alternatively fuelled vehicles	informal or formal air quality targets; demonstrating commitment to greening the fleet is essential for business competitiveness and a long term approach to investment is taken (i.e. over 6 years, up to 9 years pay back compared to diesel vehicles is acceptable)
Low to medium knowledge of AFV options; some AFVs adopted through support/funding or because payback was under 4 years	Medium to high knowledge of AFV options, some adoption of AFVs where cost-effective in short term	High knowledge of AFV options, with several technologies adopted or at least trialled (in some cases these fleet operators even pay for the research & development of a suitable AFV solution)

The specific barriers relating to national, local, and fleet strategies for reducing emissions are summarised in Table 2. Table 3 sets out the opportunities for policymakers to address these barriers, with priority levels indicating the expected relative impact on fleet operators' ability to adopt AFVs in the next 10 years.

Table 2 Barriers relating to national, local and fleet strategies

Barriers relating to national, local and fleet emissions strategies		
	Barrier	Applies to:
1	Lack of specific targets for commercial vehicle emissions reductions at national or local level.	Fleets, OEMs
2	Lack of a) long term plan and clear government mandate for low emission commercial vehicles, and b) lack of a clear definition of what classifies as a low emission commercial vehicle.	Fleets, OEMs, infrastructure providers
3	Perceived lack of consistency and clarity in overall approach to air quality and carbon emissions targets and regulation, leading to uncertainty on which technologies to adopt. - E.g. the ULEZ will allow Euro 6/VI LGVs and HGVS, with no additional incentive for zero-emission capability	Fleets, OEMs
4	Not all customers have a demand for or lower emission technology or are willing to pay for it.	Fleets (e.g. construction sector)
5	Some fleet operators do not own the vehicles (i.e. they are imposed by a client e.g. in haulage services for supermarkets, or owned by drivers), meaning that technology decision lies primarily	Fleets

	with a wider group of stakeholders who are often less environmentally motivated and/or are less aware of technology options.	
6	Uncertainty around how to include different fuel pathways (such as biomethane) in corporate social responsibility (CSR) reporting.	Fleets

Table 3 Opportunities to increase uptake via national, local and fleet strategies

Opportunities to increase uptake via national, local and fleet emissions strategies			
	Opportunities to address barriers	Priority level	Relevant stakeholders
1	<p>Policymakers should aim to define consistently at national and local level what constitutes “ultra low emissions” and “low emissions” for commercial vehicles, on the basis of evidence emerging from ongoing studies. This should address the following:</p> <ul style="list-style-type: none"> - Pollutant levels expected (including PM 2.5 where possible) compared to Euro 6 / VI baseline - CO₂ reductions expected compared to a relevant diesel baseline (which should be on a Well to Wheel basis). - Recommended approach to gas vehicles (following emerging evidence from the DfT-LowCVP HGV Methane Strategy and the DfT-LowCVP Gas Truck Trials, including the LoCITY van extension) - Approach to conversions and retrofits (to be informed by the HGV accreditation scheme) - Consideration of geofencing for PHEVs/E-REVs operating in air quality hotspots - Consideration of non-tailpipe emissions e.g. emissions from refrigeration and freezer units, brake and tyre wear, etc. 	1	OLEV, DfT, LoCITY
2	<p>Policymakers should define specific emissions reductions and/or adoption targets e.g. for ultra low emission commercial vehicles (using agreed definition)⁶. Use these targets to inform clear timelines for regulations requiring technology going beyond Euro VI / 6, both locally and nationally. This should be supported by explanations around how air quality and climate change priorities are expected to evolve. The specific points</p>	1	DEFRA, CCC, DfT, OLEV, LoCITY

⁶ An example is provided by the Draft California Sustainable Freight Action Plan http://www.casustainablefreight.org/app_pages/view/154

	defined above should be accounted for.		
3	<p>Policymakers could work to ensure that new and changing policies across departments are aligned with the above definitions and priorities.</p> <p>E.g. reporting framework for WTW emissions should be aligned with evidence for Strategy for Methane in HGVs; new homologation categories should be considered for innovative technologies that are accredited by the LowCVP programme, etc.</p> <p>From an overall policy perspective, it will be important to consider the distribution of funding for emissions reduction incentives across vehicle classes, and timescales for possible changes, given that support to date has been focused mainly on the BEV and PHEV car market, which is now relatively mature compared with commercial AFVs.</p>	2	DEFRA, DfT, OLEV
4	<p>OLEV and LoCITY should communicate definitions, targets, regulations and changes through relevant channels (this will include “centralised information point” – as discussed in next section)</p> <p>As part of this, LoCITY should work with national government and TfL to identify opportunities to provide advance notice of regulations going beyond Euro 6 / VI, and to provide information and guidance on the technologies that are likely to qualify for additional policy support. This will encourage fleets and manufacturers to adopt these technologies in advance of regulations being introduced.</p>	2	OLEV, LoCITY

Vehicle supply and demand

As previously shown (in Table 1), many of the fleet operators that were interviewed reported strong environmental motivations, actively seeking to adopt alternative fuel vehicles. However, there is currently limited availability of such vehicles, especially for HGVs and heavier LGVs, which significantly impedes the overall uptake within the commercial vehicle sector. The limited supply of vehicles manifests in three ways:

- No alternative fuel / low emission options in some vehicle classes (e.g. refuse collection vehicles above 26t)⁷
- No alternative fuel / low emission options with sufficient range, payload or power capabilities (e.g. van fleets requiring ranges and/or payloads beyond that provided by current electric van offerings; haulage companies requiring higher horse power than that provided for the available gas trucks)
- Limited volumes or long lead times on some options, such as converted or bespoke vehicles and the newest gas or electric truck models.

Until the launch of a light electric truck by Iveco (in April 2016), dedicated gas was the only alternative fuel vehicle technology available from established OEMs, for HGVs in the UK. All other technologies to date (dual fuel gas, dual fuel LPG, E-REV and H₂ ICE) have been brought to market by SMEs (UK-based, except in the case of Fuel Cell E-REVs developed by a French SME).

As well as discussing the specific performance constraints that prevent fleets from using the options which are already available, this research has explored the issue from the perspective of vehicle manufacturers (both UK-based SMEs and established OEMs). We found that manufacturers are working to bring alternative fuel technologies to market in the UK⁸ and elsewhere (with cost reductions to be expected over time), but there are several opportunities to accelerate this process and to encourage other manufacturers to make the UK a priority market for their alternative fuel offerings.

These opportunities are mainly focused on the need for UK policymakers to provide confidence to manufacturers that the policy landscape will support the market for low emission commercial vehicles. Manufacturers need their vehicles to be accessible to a range of operators. The provision of a clear, long-term framework of financial and non-financial incentives (such as exemptions to access restrictions) will give manufacturers the confidence required to bring more vehicles to market, and will help to increase levels of demand to the point at which cost parity with diesel options can be reached. It should be noted that certain financial measures, such as a zero emission HGV grant, would initially

⁷ The existing range of options (at the time of this report's publication) is shown in the Appendix.

⁸ Some manufacturers reported that in recent years, the development of alternative fuel technologies has been delayed to some extent by the focus on bringing Euro VI/6 diesel options to market.

incur very low costs due to the low availability of suitable vehicles, but would stimulate the market and go some way to addressing the issue of low availability (just as the Plug-in Van Grant has done in the last few years).

Over the next years, evidence from ongoing research (e.g. the DfT-LowCVP HGV Methane Strategy, the LowCVP HGV Accreditation Scheme and the DfT-LowCVP Gas Truck Trials, including the LoCITY van extension) will emerge, with the potential to inform the development of an overall policy framework for commercial vehicles.

For some particular applications (such as refuse and waste collection), operators have particular needs for their vehicles, which are not necessarily the same as those of other European markets⁹. In most cases, these “niche market” vehicles are unlikely to be the priority for OEMs, and alternative fuel versions from OEMs will inevitably be slower to come to market. However, timescales are still likely to benefit from a clear policy framework, and these markets may provide key opportunities for UK-based SMEs.

The barriers relating to vehicle supply and demand are summarised in Table 4.

Table 5 sets out specific opportunities for policymakers to address these barriers.

Table 4 Barriers relating to vehicle supply and demand

Barriers relating to vehicle supply and demand		
	Barrier	Applies to:
1	<p>Limited availability of alternatively fuelled vehicles that meet the operational requirements of fleets</p> <p>From the perspective of vehicle manufacturers, the following factors contribute to this (in order of significance):</p> <ul style="list-style-type: none"> - No long-term commitment from UK government to support the market (i.e. through financial and non-financial incentives to reduce the impact of cost premiums inherent to low volume production), to enable demand to extend beyond those with very strong environmental motivations. - For electric vehicles, compromise between driving range and payload is required due to energy density of current batteries and gross weight limits - Homologation process can be time consuming and costly for innovative SMEs bringing new powertrains to the market - Skills shortage of experienced, multi-disciplinary engineers for vehicle production 	<p>Fleets</p> <p>HGV manufacturers, van converters / retrofitters</p> <p>Electric vehicle manufacturers</p> <p>Converters / retrofitters / SMEs</p>

⁹ The UK market requests low entry cabs for refuse collection vehicles, because personnel go in and out of the cab over 50 times per shift. In other countries they are allowed to stay on the truck step so low entry cabs are not required.

	- No incentives or CSR reporting framework for green fuel pathways for hydrogen or bioLPG; no CSR reporting framework for biomethane	Manufacturers, infrastructure
2	Lack of clarity around the performance and benefits of different technologies for different duty cycles. Remaining areas of uncertainty include: <ul style="list-style-type: none"> - Real-world driving range for different applications - Real-world emissions and efficiency for different fuels (including pollutant and CO₂ benefits of Euro VI gas vehicles compared to Euro VI diesel, which the DfT-LowCVP Gas Truck Trials aim to address, and the impacts of methane slip and LNG boil-off) 	Fleets
3	Many fleets will not adopt a technology unless a comprehensive aftersales & maintenance package is provided, but small organisations may lack the resources or geographic diversity to provide this service (without risking compromising their business)	Fleets, converters / retrofiters / SMEs
4	Uncertainty around residual value due to lack of second life market, and the fact that manufacturers do not yet offer “buy-back” options. This is a barrier for leasing companies and fleets whose cost modelling is based on selling vehicles on after a few years.	Fleets

Table 5 Opportunities to increase uptake by addressing vehicle supply and demand

Opportunities to increase uptake by addressing vehicle supply and demand			
	Opportunities to address barriers	Priority level	Relevant stakeholders
1	Policymakers should encourage OEMs to bring new alternative fuel models to the UK, through alignment of local and national policy with the emerging evidence (e.g. LowCVP testing and Certification schemes) and consequent definitions and agreed timescales (as discussed in Table 3). Potential opportunities are outlined below:	1	See below
1.1	National policy <ul style="list-style-type: none"> - Look to extend the plug-in grant to include light trucks, through consultation with industry. Consider renaming to encompass other zero-emission capable 	2	OLEV

	<p>technologies such as hydrogen fuel cell vehicles</p> <ul style="list-style-type: none"> - Consider providing funding for other alternative truck technologies (e.g. through continuation of the Low Carbon Truck Trial) - Communicate future timescale for fuel duty differential for methane, and LPG, in advance of the review in 2018 (following evidence from Methane Strategy) - Consider re-introducing the Clean Vehicle Technology Fund, with eligibility criteria and Reduced Pollution Certificates to be in line with the implementation of HGV Certification for Aftermarket Technologies - Aim to improve visibility of the hydrogen fuel duty exemption and provide clarity on future approach - Explore options to allow additional gross weight allowance for alternative fuel vehicles in the N1 class, in the order of 300 or 500 kg, without triggering the need for an O-license or a Category C1 licence. Depending on the examination of O-license conditions, this might apply to only some powertrain types (e.g. electric, as maintenance needs are lower than for internal combustion engines) - Following the industry consultation, clarify the timeline for implementation of Directive (EU) 2015/719 which will allow up to 1 tonne additional gross weight allowance for alternative fuel vehicles in the N2 and N3 classes¹⁰ - Look to work with the VCA on homologation category definition to ensure that provision is made for emerging technologies that may not fit existing categories - Consider acknowledging green WTW pathways for hydrogen through the Renewable Transport Fuel Obligation and for hydrogen, LPG and biomethane in CSR reporting guidance (including defining a framework for reporting) - Explore options to support SMEs trying to develop aftersales networks, e.g. by providing funding (or setting up a framework) to support coordinated training programmes. 	<p>2</p> <p>1</p> <p>2</p> <p>2</p> <p>1</p> <p>1</p> <p>1</p> <p>3</p> <p>2</p>	<p>OLEV</p> <p>DfT</p> <p>DEFRA, DfT</p> <p>OLEV, DfT</p> <p>DfT</p> <p>DfT</p> <p>DfT</p> <p>DfT</p> <p>DfT, OLEV, BIS, LoCITY</p>
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¹⁰ The Directive must be implemented by May 2017; however some operators expressed the need to know the exact implementation date if earlier, as it influences their decision to buy or delay purchase of AFVs. Recent communications from DfT indicated that Autumn 2016 is the target date, but no information is available in the public domain.

<p>1.2</p>	<p>Local policy</p> <ul style="list-style-type: none"> - Aim to update criteria for Low Emission Certificates and Low Emission Zone exemptions for vehicles qualified with Reduced Pollution Certificates, following the implementation of HGV Certification for Aftermarket Technologies and based on agreed air quality and CO₂ priorities - Use the London Freight Borough Officer Liaison group (BOLG) to explore options to provide non-financial incentives for zero-emission or low carbon vehicles (e.g. exemptions to road access restrictions / delivery time constraints) - Depending on agreed strategic priorities, consider revising congestion charge discount criteria and framework to prioritise zero-emission or low carbon vehicles, including HGVs as well as vans. Electric vehicles already qualify for a 100% congestion charge discount, but this is not obvious from the current description available online, which relates mainly to cars and vans. There is a need to clarify communication regarding incentives for vehicles other than cars and vans. 	<p>2</p> <p>1</p> <p>2</p>	<p>TfL</p> <p>LoCITY, local authorities</p> <p>TfL</p>
<p>2</p>	<p>Aim to create a centralised online source of trusted, impartial information for commercial fleets, with information on the full range of low emission options. A good example of this for gas technology is the Gas Vehicle Hub website.¹¹ The site should include:</p> <ul style="list-style-type: none"> - Vehicle availability with key metrics such as driving range, power, payload, emissions test results, running costs and typical whole life costs - Case studies for different duty cycles - Maps showing public refuelling infrastructure - Details of current and planned local regulations applying to commercial vehicles, including any exemptions, discounts or other incentives applying to alternatively fuelled vehicles (<i>which should reflect the definitions and timescales defined at a national level</i>) - Details of related national policy - Information on latest funding schemes 	<p>1</p>	<p>LoCITY</p>

¹¹ www.gasvehiclehub.com/

	<ul style="list-style-type: none"> - CSR reporting guidance <p>Where appropriate, access to this information could be provided via links to existing websites.</p> <p>This should be primarily applicable to fleets operating within London but also relevant to those operating nationally and as such, should endeavour to include relevant input from local authorities outside London (e.g. on details of Clean Air Zones).</p>		
3	<p>Aim to facilitate workshops to address outstanding issues</p> <ul style="list-style-type: none"> - Continue to facilitate workshops with vehicle manufacturers, fleet innovators and followers, to enable manufacturers to learn about fleet requirements and the likely size of the AFV market, and to give them a forum to provide operators with visibility of timescales for new vehicle development. Consider including discussion of residual value estimation (e.g. manufacturer buy-back schemes, and possible timescales for this) as part of these workshops. - Consider holding a workshop for SMEs offering AFV technologies to explore opportunities for them to address skills shortages and limited aftersales capabilities 	1	LoCITY
4	<p>Look to ensure that the testing, monitoring and enforcement framework for commercial vehicle emissions supports the overall objectives:</p> <ul style="list-style-type: none"> - Test cycles relevant to Air Quality standards could include representation of driving into and out of the city as well as urban driving to ensure that the urban cycle is optimised for pollution reduction - Consider feasibility of geofencing to minimise the emissions from PHEVs and E-REVs operating in the ULEZ and any future emission controlled areas. 	2 3	DfT, TfL TfL
5	<p>Consider opportunities to address skills shortages and limited aftersales capabilities (e.g. by establishing training schemes at local colleges or forming partnerships with other SMEs with compatible technologies)</p>	3	Manufacturers (SMEs)

Infrastructure

Commercial vehicle operators have varying refuelling patterns to fit with their operations, and hence various needs in terms of alternative fuel refuelling infrastructure. Table 6 shows the main modes of refuelling, and indicates which commercial vehicle applications typically use each mode. The interviewees for this study are split across these three groups, and as such, the infrastructure-related barriers that have been identified are representative of the full range of constraints faced by fleet operators in London.

Table 6 Fleet refuelling patterns

Fleet refuelling patterns		
1 – Rely on depot-based refuelling	2 – Mainly depot based refuelling with some use of public infrastructure	3 – Rely on provision of public infrastructure
Examples: waste & refuse collection, local HGV deliveries, construction	Examples: Long haul deliveries, haulage	Examples: LGV local deliveries, utility vans, some rigid truck operators
For the use of AFVs, some of these fleets would still value a network of public infrastructure, as a 'back up option' if their depot based solution was to fail.	For the use of AFVs, these fleets don't require an extensive refuelling network but will base operations around the existing public stations and their own in-depot facilities.	For the use of AFVs, these fleets require a good public network. Most are happy to use semi-public refuelling points. For electric vans, residential charging is compatible with these fleets.

As shown in Table 6, not all fleets require public refuelling infrastructure, but those that do represent a significant share of the overall commercial vehicle fleet. Several operators interviewed as part of this study have AFVs operating outside London, but are currently unable to operate AFVs in London due to the lack of public infrastructure (and/or a lack of willingness to install in-depot infrastructure in London). The reasons behind this have been explored in detail.

One key issue is the cost of infrastructure, which must either be borne by the fleet operator (for most in-depot installations) or by the infrastructure provider (for public infrastructure, or in the case of contracted agreements with fleets for in-depot station), in which case there must be a sufficient "anchor demand" to support a viable business case for the infrastructure provider. Identifying this level of demand (in a reasonably limited AFV

market) is one of the fundamental barriers to infrastructure deployment, and several opportunities to address this in London have been identified.

The range of barriers that apply to non-public infrastructure, and to specific types of fuel and infrastructure, have also been explored. The key infrastructure-related barriers to adoption of AFVs in London and the opportunities to address these barriers are set out Table 7 and Table 8 respectively.

Table 7 Barriers relating to refuelling / charging infrastructure

Barriers relating to refuelling / charging infrastructure		
	Barrier	Applies to:
1	<p>Lack of sufficient public infrastructure coverage (rapid charge points, gas stations, hydrogen stations)</p> <p>From the perspective of infrastructure providers, the following factors contribute to this (in order of significance):</p> <ul style="list-style-type: none"> - Difficulty identifying sufficient demand to provide confidence for business case - Availability and cost of land in London - Length of planning permission process causes delays to network development 	<p>Fleets</p> <p>Infrastructure</p> <p>Infrastructure</p> <p>Infrastructure</p>
2	<p>Capital costs of infrastructure can be very high and cannot always be covered by UK Government funding (i.e. for depot installations, workplace charging points, or public gas stations). Many fleets don't own their depots or have a short lease, limiting their appetite for significant investment in infrastructure</p> <p>Many infrastructure providers offer a contract model for depot based installations, where they cover the capital costs, but to make the business case viable this usually requires adoption of more than a few vehicles by one fleet, which can prevent uptake by cash flow constrained organisations (particularly relevant for hydrogen stations and rapid charging points)</p>	<p>Infrastructure,</p> <p>Fleets</p>
3	<p>Some fleets have insufficient space in their depots to accommodate refuelling / recharging infrastructure</p>	<p>Fleets</p>
4	<p>Residential charging</p> <p>Drivers do not always have access to off-street parking and there is currently no workable residential on-street charging solution</p>	<p>Van operators</p>
5	<p>Public charging points</p>	

	No way to easily check or guarantee rapid charge point availability. This is exacerbated by the existence of numerous charging networks, each requiring their own membership; there is no centralised map or app with live availability data for all networks.	Van operators
6	<p>Depot charging</p> <p>Unfamiliarity with process of engaging with distribution network operator to arrange network upgrades (required to support multiple vehicles charging simultaneously). Note that this is starting to be addressed; UK Power Networks have been reaching out to fleets to communicate the process and requirements</p> <p>Fleet operators seeking to charge multiple vehicles simultaneously at high power have to pay high costs of upgrading the local electricity distribution network, paying for assets which are still owned by the network operator</p>	<p>Fleets</p> <p>Fleets</p>
7	<p>CNG & LNG</p> <p>Lack of transparency on fuel prices (note that this is starting to be addressed by industry as a result of this being discussed with infrastructure providers during this research¹²)</p> <p>Limited supply of biomethane (and no UK supply of liquid biomethane)</p>	<p>HGV operators</p> <p>HGV operators</p>
8	<p>LPG stations</p> <p>Limited information on the locations of LPG stations that can be used by HGVs (i.e. without a low canopy).</p>	Fleets
9	<p>Hydrogen, LNG & LPG stations</p> <p>Deliveries of these fuels cannot currently be made via the Blackwall tunnel, which makes it expensive to deliver to certain areas of London and thereby restricts infrastructure development</p> <p>A small number of fleets have concerns around safety of these fuels that prevent them from considering these vehicles or from installing in-depot refuelling facilities</p>	Hydrogen, LNG & LPG infrastructure & vehicle providers

¹² CNG Fuels started publishing a CNG price index in April 2016: <http://www.cngfuels.com/wp-content/uploads/2016/02/CNG-Pricing-Mar16-1.jpg>

Table 8 Opportunities to address refuelling and charging infrastructure-related barriers

Opportunities to address refuelling and charging infrastructure related barriers			
	Opportunities to address barriers	Priority level	Relevant stakeholders
1	<p>Help to match demand and supply of infrastructure</p> <ul style="list-style-type: none"> - Aim to establish a request list process for fleets to identify ideal locations for infrastructure in London. Ideally, results could be included as part of the centralised online resource. - Facilitate alignment of deployment timescales by enabling information sharing between innovative fleet operators, infrastructure providers and vehicle manufacturers, e.g. through LoCITY workshops - Public sector fleets should lead by example by adopting alternatively fuelled vehicles. Also, when procuring services, public authorities could strongly encourage the use of alternatively fuelled vehicles and (crucially) should have a procurement scoring system that reflects this priority. - To support this, LoCITY should identify and help to address potential legal barriers to AFV procurement by liaising with legislators at European level, e.g. to improve the framework set out in the Green Public Procurement Guidance. Also, LoCITY should ensure that experience of low emission vehicle procurement (e.g. as gained through the Low Carbon Vehicle Public Procurement Programme) is shared between public sector organisations. This could be through workshops or simply establishing key contact points. - In addition, visibility of alternative fuel vehicles should be maximised (e.g. through use of eye-catching key words and relevant graphics on TfL and local authority vehicles). 	1	<p>LoCITY, OLEV</p> <p>LoCITY</p> <p>TfL, GLA, Boroughs</p> <p>LoCITY</p> <p>TfL, GLA, Boroughs</p>
2	<p>Facilitate site identification process</p> <ul style="list-style-type: none"> - Local authorities could help to: <ol style="list-style-type: none"> 1) Identify land earmarked for commercial/industrial development (this could make use of / be included as an update to the GLA database of public sector estate available for development¹³ 	1	GLA, Boroughs, TfL

¹³ <http://data.london.gov.uk/dataset/gla-group-land-assets>

	<p>2) Identify land owners</p> <p>3) Assess impact on traffic flow</p> <ul style="list-style-type: none"> - If local authorities make specific sites available, infrastructure providers should be consulted on details such as lease length to ensure that this supports a viable business case - The update to the London Plan could include requirements to provide refuelling & recharging infrastructure in areas with identified demand - Consider developing national planning guidance and/or training courses for local authorities to become familiar with process for refuelling stations - Where low emission refuelling infrastructure at specific Green Belt sites would be supported at a high level (i.e. by DCLG), communicate this to relevant planning offices to enable a precedent to be set as smoothly as possible 		<p>GLA</p> <p>DCLG, infrastructure providers</p> <p>GLA, Boroughs, DCLG</p>
3	Work to support the development of a unified live map or app showing locations and availability of public infrastructure	2	Infrastructure providers, OLEV
4	Consider investigating issues and solutions for commercial vehicles within trials of residential on-street charging technology	3	TfL, Boroughs
5	LoCITY could introduce forums or workshops for shared learning around refuelling and recharging for commercial vehicles, which should specifically enable discussions around innovative solutions	2	LoCITY
6	<p>Continue liaising with Ofgem and DECC to explore options to manage distribution network upgrade costs incurred by fleets requiring multiple high power charge points. Also, aggregate information provided by DNOs (for fleets) on centralised website.</p> <p>Look to engage with other local authorities across the UK to share experience in this area.</p> <p>Consider providing a platform for third parties to suggest financing solutions.</p>	2	<p>OLEV, LoCITY</p> <p>LoCITY</p> <p>Infrastructure providers, fleets</p>
7	Support and / or engage with R&D and trials of energy	2	LoCITY

	storage solutions that could enable simultaneous fleet charging while avoiding distribution network upgrades		
8	Information on LPG station HGV-compatibility could be shared through a centralised website	2	LPG station operators, LoCITY
9	London Councils London Freight Borough Officer Liaison group (BOLG) could explore possible opportunities to allow some access to the Blackwall tunnel (e.g. for a few hours at night when there is very little traffic) for trucks carrying LNG, LPG and hydrogen	3	Local authorities (BOLG), LoCITY

Recommendations

The opportunities to mitigate the barriers to adoption discussed in the previous chapter are collated here, in the form of recommendations. Table 9 - Table 12 set out these recommendations, focusing in turn on the potential roles for national government, TfL and LoCITY, local authorities, and other industry stakeholders (i.e. fleets, vehicle manufacturers and infrastructure providers).

Indicative timescales are set out in the tables. In general, the earlier the recommendations are implemented, the better for AFV deployment. However, realistically even the process of defining priorities, targets and timescales for commercial vehicle emissions reduction will take several months, and subsequent actions (e.g. those around updating and implementing policy relevant to AFVs) will take at least a year. In the coming months, results are expected from several on-going activities that will feed into these actions (e.g. the Strategy for Methane in HGVs, HGV Certification for Aftermarket Technologies). Based on discussions with DfT and OLEV, some of the recommended actions are already underway (such as consideration of extending the plug-in van grant to trucks).

Recommendations for each stakeholder are ordered primarily in order of dependency: actions that should inform subsequent actions are presented first. Where there are several actions that could occur concurrently, these are prioritised by their potential impact on fleet operators' ability to adopt AFVs in the next 10 years. This order is indicative and open to interpretation, and all the recommended presented here are considered to represent significant opportunities, based on the interviews conducted as part of this study.

Actions are not all expected to be implemented in the short term. For example, defining priorities, targets and timescales for commercial vehicle emissions reduction will take several months, whereas updating national policies and guidance could take a year or more.

Roles for national government

Table 9 Recommendations for national government

	Recommendations for national government	Suggested responsibility	Indicative timescale
1	<p>Aim to provide consistent definitions of “ultra low emissions” and “low emissions” for commercial vehicles</p> <p>These definitions should address the following:</p> <ul style="list-style-type: none"> - Pollutant levels expected (including PM 2.5 where possible) compared to Euro 6 / VI baseline 	DfT	Short term

	<ul style="list-style-type: none"> - CO₂ reductions expected compared to a relevant diesel baseline (which should be on a Well to Wheel basis). - Recommended approach to gas vehicles (following emerging evidence from the DfT-LowCVP HGV Methane Strategy and the DfT-LowCVP Gas Truck Trials, including the LoCITY van extension) - Approach to conversions and retrofits (to be informed by the HGV accreditation scheme) - Consideration of geofencing requirements for PHEVs/E-REVs operating in air quality hotspots - Consideration of non-tailpipe emissions e.g. emissions from refrigeration and freezer units, brake and tyre wear, etc. 		
<p>2</p>	<p>Aim to define specific emissions reductions and/or adoption targets e.g for ultra low emission commercial vehicles (using agreed definition)¹⁴</p> <p>Use these targets to inform the development of clear timelines for national regulations (and a framework for city level regulation) requiring technology going beyond Euro VI / 6. This should be supported by explanations around how air quality and climate change priorities are expected to evolve. The specific points defined above should be accounted for.</p>	<p>DECC CCC DfT</p>	<p>Short term</p>
<p>3</p>	<p>Government should address national policy on alternatively fuelled vehicles and align with defined priorities and emerging evidence. From an overall policy perspective, it will be important to consider the distribution of funding for emissions reduction incentives across vehicle classes, and timescales for possible changes, given that support to date has been focused mainly on the plug-in car market, which is now relatively mature compared with commercial AFVs.</p> <ul style="list-style-type: none"> - Consider extending the plug-in grant to include light trucks, through consultation with industry. Consider renaming to encompass other zero- 	<p>OLEV</p> <p>OLEV</p>	<p>Mid to long term</p>

¹⁴ An example is provided by the Draft California Sustainable Freight Action Plan http://www.casustainablefreight.org/app_pages/view/154

	<p>emission capable technologies such as hydrogen fuel cell vehicles</p> <ul style="list-style-type: none"> - Consider providing funding for other alternative truck technologies (e.g. a through a continuation of the Low Carbon Truck Trial) - Communicate future timescale for fuel duty differentials for methane, and LPG, in advance of the review in 2018 (following evidence from Methane Strategy) - Investigate re-introducing the Clean Vehicle Technology Fund, with eligibility criteria and Reduced Pollution Certificates to be in line with the implementation of HGV Certification for Aftermarket Technologies - Aim to improve visibility of hydrogen fuel duty exemption and provide clarity on future approach - Explore options to allow additional gross weight allowance for alternative fuel vehicles in the N1 class, in the order of 300 or 500 kg, without triggering the need for an O-license or a Category C licence. Depending on the examination of O-license conditions, this might apply to only some powertrain types (e.g. electric, as maintenance needs are lower than for internal combustion engines) - Following the industry consultation, clarify the timeline for implementation of Directive (EU) 2015/719 which will allow up to 1 tonne additional gross weight allowance for alternative fuel vehicles in the N2 and N3 classes - Look to work with the VCA on homologation category definition to ensure that provision is made for emerging technologies that may not fit existing categories - Consider acknowledging green WTW pathways for hydrogen through the Renewable Transport Fuel Obligation and for hydrogen, LPG and biomethane in CSR reporting guidance (including defining a framework for reporting) - Explore options to support SMEs trying to develop aftersales networks, e.g. by providing funding (or setting up a framework) to support coordinated training programmes. 	<p>OLEV</p> <p>DfT</p> <p>DEFRA, DfT</p> <p>OLEV, DfT</p> <p>DfT</p> <p>DfT</p> <p>DECC, DfT</p> <p>DfT</p> <p>DfT, OLEV, BIS</p>	
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4	OLEV should communicate national priorities and targets through platforms such as LoCITY and LowCVP, and provide input to a centralised online resource (this will be led by LoCITY).	OLEV	Continuous
5	Continue liaising with Ofgem and DECC to explore options to manage distribution network upgrade costs incurred by fleets requiring multiple high power charge points.	OLEV	Continuous
6	Consider developing national planning guidance and or / training courses for local authorities to become familiar with process for refuelling stations	DCLG	Mid term
7	Aim to support the development of a unified live map or app showing locations and availability of public refuelling and recharging infrastructure	OLEV	Long term

Roles for local authorities and Transport for London

Table 10 Recommendations for local authorities and Transport for London

	Recommendations for local authorities and Transport for London	Suggested responsibility	Indicative timescale
1	Aim to define what constitutes “ultra low emissions” and “low emissions” for commercial vehicles in London, on the basis of evidence emerging from ongoing studies (e.g. the DfT-LowCVP Gas Truck Trials and the LoCITY van extension) and in keeping with national definitions.	TfL	Short term
2	Aim to define specific emissions reductions and/or adoption targets e.g. for ultra low emission commercial vehicles in London (using agreed definition)	TfL	Short term
3	Use definitions and targets to inform the development of clear timelines for local regulations requiring technology going beyond Euro VI / 6. - Consider updating criteria for Low Emission Certificates and Low Emission Zone exemptions for	TfL	Mid term

	<p>vehicles qualified with Reduced Pollution Certificates, following the implementation of HGV Certification for Aftermarket Technologies and based on agreed air quality and CO₂ priorities</p> <ul style="list-style-type: none"> - Depending on agreed strategic priorities, consider revising congestion charge discount criteria and framework to prioritise zero-emission or ultra low emission vehicles, including HGVs as well as cars and vans 	TfL, GLA, Boroughs	
4	<p>Public sector fleets (including TfL fleets) should lead by example by adopting alternatively fuelled vehicles. Also, when procuring services, public authorities could strongly encourage the use of alternatively fuelled vehicles and (crucially) should have a procurement scoring system that reflects this priority.</p> <p>To support this, they could provide input to LoCITY to help them to liaise with legislators at European level to improve the framework set out in the Green Public Procurement Guidance.</p> <p>In addition, visibility of alternative fuel vehicles should be maximised (e.g. through use of eye-catching key words and relevant graphics on TfL and local authority vehicles).</p>	GLA, Boroughs, TfL	Continuous
5	<p>Work to ensure that the testing, monitoring and enforcement framework for commercial vehicle emissions supports TfL's overall objectives for emissions reduction:</p> <ul style="list-style-type: none"> - TfL test cycles to test adherence to air quality regulations (e.g. DfT-LowCVP van extension) could include representation of driving into and out of the city as well as urban driving - Consider feasibility of geofencing to minimise the emissions from PHEVs and E-REVs operating in the ULEZ and any future emission controlled areas. 	TfL TfL	Mid term
6	<p>In partnership with LoCITY, use the London Councils London Freight Borough Officer Liaison group (BOLG) to explore options to provide non-financial incentives</p>	Boroughs (BOLG)	Mid to long term

	for zero-emission or low carbon vehicles (e.g. exemptions to road access restrictions / delivery time constraints).		
7	<p>Aim to help infrastructure network development by:</p> <ol style="list-style-type: none"> 1) Identifying land earmarked for commercial/industrial development (this could make use of / be included as an update to the GLA database of public sector estate available for development¹⁵) 2) Identifying land owners 3) Assessing impact on traffic flow <p>If local authorities make specific sites available, infrastructure providers should be consulted on details such as lease length to ensure that this supports a viable business case</p>	Boroughs, GLA	Continuous
8	Consider investigating issues and solutions for commercial vehicles within trials of residential on-street charging technology	TfL, Boroughs	Mid to long term
9	<p>Where low emission refuelling infrastructure at specific Green Belt sites would be supported at a high level (i.e. by DCLG), communicate this to relevant planning offices to enable a precedent to be set as smoothly as possible</p> <p>Requirements to provide refuelling & recharging infrastructure in areas with identified demand could be included as part of the update to the London Plan</p>	GLA	Mid term
8	London Councils London Freight Borough Officer Liaison group (BOLG) could explore possible opportunities to allow some access to the Blackwall tunnel (e.g. for a few hours at night when there is very little traffic) for trucks carrying LNG, LPG and hydrogen	Boroughs (BOLG)	Mid to long term

¹⁵ <http://data.london.gov.uk/dataset/gla-group-land-assets>

Roles for LoCITY

Several of the actions identified in Table 11 (below) are already underway or planned as part of the LoCITY programme. This reflects the clear demand for such a programme from industry, and suggests that it has the potential to make a significant contribution to reducing the barriers to AFV adoption.

Table 11 Recommendations for LoCITY

	Recommendations for LoCITY	Indicative timescale
1	<p>Aim to act as a link between policymakers and industry stakeholders by communicating emissions targets, regulations and other useful information to fleets and other stakeholders.</p> <p>A key aspect of this will be the creation of a centralised online source of trusted, impartial information for commercial fleets. This should include the following:</p> <ul style="list-style-type: none"> - Vehicle availability with key metrics such as driving range, power, payload, emissions test results, running costs and typical whole life costs - Case studies for different duty cycles - Maps showing public refuelling infrastructure - Details of current and planned local regulations applying to commercial vehicles, including any exemptions, discounts or other incentives applying to alternatively fuelled vehicles - Details of related national policy - Information on latest funding schemes - Fleet request list for infrastructure - Information from DNOs about network upgrade process - CSR reporting guidance <p>This should be primarily applicable to fleets operating within London but also relevant to those operating nationally and as such, should endeavour to include relevant input from local authorities outside London (e.g. on details of Clean Air Zones).</p> <p>In addition, LoCITY should work with TfL and national government to identify opportunities to provide advance notice of regulations going beyond Euro 6 / VI, and to provide information and guidance on the technologies that are likely to qualify for additional policy support. This will encourage fleets and manufacturers to adopt these technologies in advance of regulations being introduced.</p>	Short term

2	<p>Support TfL and industry in exploring options for local trials and regulatory measures</p> <ul style="list-style-type: none"> - LoCITY should work with Boroughs through the London Councils London Freight Borough Officer Liaison group (BOLG), to explore options to provide non-financial incentives for zero-emission or low carbon vehicles (e.g. exemptions to road access restrictions, or to delivery time constraints, such as allowing out of hours deliveries for technologies that can meet noise requirements) - Support and / or engage with R&D and trials of energy storage solutions that could enable simultaneous fleet charging while avoiding distribution network upgrades - Work with TfL on the development and implementation of London-specific test cycles (e.g. DfT-LowCVP van extension) 	Continuous
4	<p>Continue facilitating workshops to address outstanding issues</p> <ul style="list-style-type: none"> - LoCITY should continue to facilitate workshops with vehicle manufacturers, fleet innovators and followers. This will enable manufacturers to learn about fleet requirements and the likely size of the AFV market, and will give them a forum to provide operators with visibility of timescales for new vehicle development. Discussion of residual value estimation (e.g. manufacturer buy-back schemes, and possible timescales for this) could be included as part of these workshops. - Workshops for SMEs offering AFV technologies should also be considered, to enable them to explore opportunities to address skills shortages and limited aftersales capabilities (e.g. by establishing training schemes at local colleges or forming partnerships for compatible technologies) - Forum or workshops could be used to discuss shared learning around charging and refuelling for commercial vehicles, and should specifically enable discussions around innovative solutions 	Continuous
5	<p>Help to match demand and supply of infrastructure</p> <ul style="list-style-type: none"> - Aim to establish a request list process for fleets to identify ideal locations for infrastructure in London. Ideally, results could be included as part of the centralised online resource. - Facilitate alignment of deployment timescales by enabling information sharing between innovative fleet operators, infrastructure 	Continuous

	<p>providers and vehicle manufacturers, e.g. through LoCITY workshops</p> <ul style="list-style-type: none"> - To support fleets in procuring AFVs, LoCITY should identify and help to address the potential legal barriers by liaising with legislators at European level, e.g. to improve the framework set out in the Green Public Procurement Guidance. Also, LoCITY should ensure that experience of low emission vehicle procurement (e.g. as gained through the Low Carbon Vehicle Public Procurement Programme) is shared between public sector organisations. This could be through workshops or simply establishing key contact points. 	
6	<p>Consider setting up a programme to recognise industry stakeholders that are actively participating in trials and / or workshops, or that are otherwise supporting LoCITY’s work to address the barriers to AFVs. This could follow the example set by the successful CLOCS Champions (Construction Logistics and Cyclist Safety) scheme.</p>	Short term

Roles for fleet operators, infrastructure providers and vehicle manufacturers

Table 12 Recommendations for industry stakeholders

	Recommendations for fleet operators, infrastructure providers and vehicle manufacturers	Suggested responsibility	Indicative timescale
1	<p>Stakeholders should engage with OLEV & DfT on definitions, priorities and timescales for alternatively fuelled vehicles (/ low emission vehicles). Provide input to the development of specific incentives, regulations and voluntary measures, including responding to consultations as appropriate</p>	<p>Vehicle manufacturers, fleet operators, FTA</p>	Short term
2	<p>Stakeholders should engage with TfL and other local authorities on potential local measures relevant to AFVs, e.g. charging scheme discounts; exemptions to access restrictions</p>	<p>Fleet operators, vehicle manufacturers</p>	Mid to long term
3	<p>Aim to work with LoCITY to provide information to be collated on a centralised website on alternative fuelled vehicles for use by fleet operators:</p> <ul style="list-style-type: none"> - Current locations of infrastructure and (where possible) those in planning stages (including HGV compatible LPG stations) 	<p>Infrastructure providers</p>	Continuous

	<ul style="list-style-type: none"> - Information on alternative fuel vehicle offerings and timescales for future options - Case studies showing real-world range (and overall operating costs) of alternative fuelled vehicles in specific applications <p>In addition, identify other opportunities for your organisation to support LoCITY and be recognised as an exemplary contributor.</p>	<p>Vehicle manufacturers</p> <p>Fleets</p>	
4	Manufacturers and fleet operators should engage with the development of new emissions testing frameworks (LowCVP and TfL) and ensure that processes are set up for testing as vehicles become available. Communicate any barriers to testing to LoCITY or DfT.	Vehicle manufacturers , (fleet operators)	Continuous
5	Infrastructure providers should use information provided by fleets and by LoCITY (e.g. infrastructure request list) to identify new siting opportunities and communicate to LoCITY where further information is needed to inform business case	Infrastructure providers	Continuous
6	Charging point providers should share data to support the development of a unified live map or app showing locations and availability of public charging points	Charging point providers	Continuous
7	Liaise with Health & Safety standards authorities and provide input to the DCLG, to contribute to the development of official planning guidance around refuelling infrastructure for local authorities	Infrastructure providers	Mid term
8	Infrastructure providers could provide a platform for third parties to suggest financing solutions for network upgrades to support in-depot fleet charging and refuelling	Infrastructure providers, fleets	Continuous
9	Stakeholders can continue to participate in forums and workshops that enable shared learning and discussion of new opportunities to address the current barriers	Infrastructure providers, vehicle manufacturers , fleets	Continuous
10	SMEs should consider opportunities to address skills shortages and limited aftersales capabilities (e.g. by	Manufacturers (SMEs)	Short to mid term

	establishing training schemes at local colleges or forming partnerships with other SMEs with compatible technologies)		
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Aligning the approach

The implementation of the recommendations set out for the various stakeholders will rely on a collaborative approach between national government, local government and industry. The recommendations around overall policy development apply to several government departments, and it will be essential that these departments work together to ensure that policy around alternative fuel vehicles is consistent, and to establish a cohesive framework that addresses both air quality and CO₂ policy objectives. Where possible, developments that go beyond European requirements should be used to inform change at EU level, and to lobby for greater consistency in EU regulatory environment. Fleet operators, vehicle manufacturers and infrastructure providers should engage with the policy development process wherever possible (e.g. through organisations such as the FTA, RHA), to ensure that nationally agreed objectives are achievable and supported by appropriate market development plans and policy measures.

Improving air quality is the primary focus of LoCITY (with CO₂ reductions being a secondary objective). However, for some alternatively fuelled vehicle technologies, the greatest contributions to local and national targets could be those made on a well-to-wheel CO₂ basis. In these cases, consideration of the wider energy policy context is needed to ensure that the potential benefits can be achieved.

The policy framework around biomethane is a specific example of where this needs to be addressed. There is an opportunity for DECC and DfT to reassess the role of biomethane in decarbonising heat and transport, in light of the relative demand shown from the two sectors, emerging evidence around the benefits of gas vehicles, and taking account of the latest roadmaps for heat decarbonisation. This could potentially inform a reconfiguration of the incentives for use of biomethane in heat and transport, with the opportunity to address the current limited supply of liquefied biomethane (i.e. biomethane used directly for transport, rather than being grid injected).

For the benefits of national policy to have impacts at the London level, it will be important for local policy measures in London to be aligned with the national objectives and priorities. As such, TfL should also engage with the policy development process and consider whether current local measures are consistent with air quality and CO₂ policy objectives and how these are expected to evolve over the next 10-15 years. In implementing local measures, TfL should seek to consult with other local authorities with similar objectives, and where possible, measures across different cities should be aligned, in order to minimise potential re-routing effects but also to provide a more consistent and accessible framework for fleet operators.

Infrastructure provision is a particular constraint for London, both in terms of space and (for charging points) network capacity, and this needs to be addressed to support wider uptake of AFVs. As well as engaging with industry stakeholders through LoCITY, TfL should continue to learn from the experiences of other UK cities, and take note of the success or otherwise of any innovative approaches. For example, under the Go Ultra Low City Scheme, Dundee plans to install charging hubs across the city. The impacts of this on the use of electric commercial vehicles could be a useful point of reference for London and TfL should engage with the results of this and other Go Ultra Low City projects (and compare to London's own Go Ultra Low scheme), from the perspective of commercial vehicles as well as from a private user perspective. In the City CNG Project, Leeds City Council is exploring a novel business model to cover the cost of a high pressure gas grid connection for a city-based gas station; here, too, there are likely to be relevant experiences to draw on for London-based infrastructure. Further to engaging with UK-based projects, LoCITY should seek opportunities to explore the results of low emission freight projects (and policy decisions around particular barriers) in other EU member states.

Finally, future work to develop the public infrastructure network should also take account of any parallel work on consolidation centres. Consolidation centres designed to maximise loading and minimise the number of city centre trips by heavy vehicles can inherently reduce emissions in cities if used in appropriate applications, but they could also be designed to optimise the use of different low emission technologies for long haul vs. city centre operations, and could include refuelling or recharging facilities to support this. As such, policymakers and industry should be aware of work in this area (e.g. the LaMiLo project) and make the most of any opportunities to align this work with other infrastructure development projects.

Appendix

Literature review

Table 13 provides a list of the reports or resources reviewed to derive a long list of barriers to uptake of AFVs, to supply of AFVs and to deployment of refuelling/recharging infrastructure. The table also indicates what vehicle and fuel types were covered, if infrastructure was included and the level of relevance for this study. The list of barriers derived for discussion with interviewees is shown in Table 14.

Table 13 List of reports reviewed as part of this study

Report (title)	Author(s)	Date of publication	Public report	Vehicle type		Fuel type			Infrastructure	Relevance	Interview /workshop
				Vans	HGVs	Gas	Hydrogen	Electricity			
Low Carbon Truck and Refuelling Infrastructure Demonstration Trial Evaluation (first two annual reports)	Department of Transport	June 2014, July 2015	x		x	x			x	Medium	
Low Emission HGV Task Force, Recommendations on the use of methane and biomethane in HGVs	Department for Transport	March 2014	x		x	x			x	High	
The Low Emission Van Guide	LowCVP	June 2015	x	x		x		x		Low	
Opportunities to overcome the barriers to uptake of low emission technologies for each commercial vehicle duty cycle	Ricardo-AEA, for LowCVP	November 2012	x		x	x	x	x		High	x
Clean fleet guides	Clean fleets	On-going	x							Medium	
Plugged in Fleets Initiative	Energy Saving Trust	January 2013	x	x				x	x	High	x
Validating freight electric vehicles in urban Europe	FREVUE	September 2011	x	x	x			x		High	x
Configurable and adaptable trucks and trailers for optimal transport efficiency	Project Transformers	April 2014	x		x			x		Low	
Possibilities and barriers for using electric-powered vehicles in city logistics practice	European project CITYLAB	June 2015	x	x	x			x		Medium	
Design of electric light vans for environment impact reduction	European project DELIVER	April 2015	x	x				x		Low	
Low Emission Commercial Vehicle Workshop	Transport for London	Jul-15		x	x	x	x	x	x	High	x
Transport Energy Infrastructure Roadmap to 2050 - Liquid fuels	Element Energy, for LowCVP	June 2015	x	x	x				x	Medium	x
Transport Energy Infrastructure Roadmap to 2050 - Methane	Element Energy, for LowCVP	June 2015	x	x	x	x			x	High	x
Transport Energy Infrastructure Roadmap to 2050 - Electricity	Element Energy, for LowCVP	June 2015	x	x	x			x	x	High	x
Transport Energy Infrastructure Roadmap to 2050 - Hydrogen	Element Energy, for LowCVP	June 2015	x	x	x		x		x	High	x
Installing accessible hydrogen refuelling stations, A best practice guide	Element Energy, for Innovate UK	July 2015	x	x			x		x	High	x
Alternative fuels strategy for the Liverpool City Region	Element Energy, for Sefton Council	January 2016			x	x			x	High	x
A City blueprint for low carbon fuel refuelling infrastructure	Element Energy, for Birmingham	February 2015	x	x	x	x	x	x	x	High	x
Ultra Low Emission Delivery Plan (reporting on the Rapid charging network study)	Transport for London	July 2015	x					x	x	High	x
Participation in FREVUE meetings	Element Energy	2013-2016			x					High	x
Exploring the market for compressed natural gas light commercial vehicles in the United Kingdom	Loughborough University, for LCV GRID (Low Carbon Vehicle Gas Refuelling Infrastructure)		x	x		x				Medium	x
InnoVative Flexible Electric Transport	European project V-FEATHER		x	x				x		Medium	

Table 14 Barriers to alternatively fuelled commercial vehicle uptake identified through review of existing literature

<p>Vehicle supply & capabilities</p>	<p>Barriers for fleets</p> <ul style="list-style-type: none"> A. No suitable alternatives available for specific segment B. No vehicles from preferred manufacturers C. Range or payload constraints would impose significant operational changes and reduce flexibility D. Lack of clarity on variation in capabilities for different usage patterns e.g. fuel economy or driving range E. After-sales support services (e.g. repairs) prohibitively lengthy F. Driver training is required to get the most out of the new technology <p>Barriers for manufacturers</p> <ul style="list-style-type: none"> A. Alternative fuel powertrains cannot be integrated easily with existing chassis designs and/or lead to reduced payload and/or reduced driving range B. Components are too expensive (e.g. battery, fuel cell, gas engine) C. Regulations around weight restrictions and vehicle classifications D. Low volume markets for vans and HGVs make investment difficult E. Differences in needs in terms of vehicle specifications, compared to other right-hand drive markets F. Lack of certainty over government long term plans G. Existing level of refuelling/recharging infrastructure is insufficient to meet customer expectations H. Immature supply chain and lack of skilled engineers for maintenance of alternative fuel vehicles I. Uncertainty around residual values is a barrier to sales
<p>Constraints for public and semi-public refuelling infrastructure</p>	<p>Barriers for fleets</p> <ul style="list-style-type: none"> A. Insufficient infrastructure nearby <ul style="list-style-type: none"> – For rapid chargers, no way to guarantee availability when required B. Existing infrastructure is not reliable (or incompatible) C. Use of shared refuelling facilities is prohibitive due to tight refuelling timescales <p>Barriers for infrastructure providers</p> <ul style="list-style-type: none"> A. Poor economics due to low penetration of vehicles and poor utilisation B. Lack of funding to support capex or opex C. Identifying suitable, affordable sites in London is time consuming and challenging D. Planning permission process is lengthy E. Gaining access to electricity grid or gas grid (for CNG stations) <p>For charging infrastructure providers</p> <ul style="list-style-type: none"> A. Difficulty in achieving a common understanding between the multiple stakeholders in equipment and site ownership arrangements B. Unclear network governance arrangements e.g. potential transfer of ownership / operation from public to private sector C. Challenges of interacting with multiple energy suppliers and achieving a fair and consistent pricing structure across London D. Highly loaded electricity grid leading to high electricity network reinforcement costs when installing charge points E. Incompatibility of rapid CPs with majority of PHEVs on the market F. Excessive re-charging time to allow viable commercial fleet operations without negatively affecting economics/performance <p>For hydrogen, methane and LPG infrastructure providers</p> <ul style="list-style-type: none"> A. Inconsistent interpretation of standards on safe siting practices B. Storage limits and consents for LNG and hydrogen C. Different pressure standards in the UK and in the EU (CNG stations) D. Gas transportation through tunnels where restrictions for the transportation of gases apply E. Variety of compatible nozzles and pressures across vehicles on the market F. Management of methane venting/boil-off or methane leaks (for CNG/LNG stations)

(cont’)- Barriers to alternatively fuelled commercial vehicle uptake identified through review of existing literature

<p>Constraints for depot-based infrastructure (and residential charging)</p>	<p>Barriers for fleets</p> <ul style="list-style-type: none"> A. High capital cost associated with installing own infrastructure B. Logistics of refuelling/recharging prohibitive beyond trial status. e.g. space/timings/complexity of implementation e.g.: <ul style="list-style-type: none"> – Space required (either for infrastructure itself or required to enable fuelling of multiple vehicles) is too great – Lack of full ownership of depot (e.g. short lease) leading to difficulty around financial case or obtaining permission to install charging/refuelling infrastructure permission – Lack of access to gas grid or 3 phase electricity – Unfamiliarity with regulations, safety requirements, and processes specific to alternative fuels C. Difficulty in providing charging solutions at drivers’ homes <p>Barriers for infrastructure providers</p> <p>Many of the barriers for public infrastructure also apply here</p>
<p>Internal targets & external policy</p>	<ul style="list-style-type: none"> A. Absence of long-term emissions targets (internally or from customers) B. Lack of clear mandate from government for lower emission truck technologies and fuels C. Lack of clear priorities from national government over air quality and carbon emissions D. Lack/weak internal communication E. Lack of review of procurement process, priorities and technology scope

Summary of current policy landscape

Measures to support the uptake alternatively fuelled commercial vehicles to date have included a range of trials and funding schemes. They are summarised in Figure 5.

Drastic emissions reductions across the transport sector will be essential to realise UK carbon emissions and air pollution reduction strategies

- Carbon Plan – Identified industry drive to reduce freight emissions
- Air quality in cities– the European Commission Transport 2050 Strategy calls for clean urban deliveries from 2030; ULEZ in London announced and 5 Clean Air Zones expected as part of DEFRA new AQ plan

Main government and EU support for low carbon vans and trucks

- **£600 million** will be invested by OLEV from 2015 to 2020 to support ultra low emission vehicles and infrastructure, including the **Plug-in Van grant** and **£4 million for HGV gas infrastructure**
- **Preferential gas fuel duty differential** announced in December 2013, to be maintained to 2024 (25p/kg for gas; 58p/l for diesel translating into a difference of c. 11p/km). Differential also offered for LPG.
- **Low Emission HGV Task Force:** government and industry working together to make recommendations for the uptake of gas trucks
- **Low Carbon Truck trial: £11.3 million** invested by OLEV and TSB (now Innovate UK) to develop the market for low carbon trucks and infrastructure. Most of the vehicles in the trial are gas trucks.
- EU co-funded trial for **electric trucks delivering in cities** (FREVIEW project: Freight Electric Vehicles in Urban Europe), £18million budget; EU funded projects such as Hydrogen Mobility Europe will include funding for hydrogen range extended vans.

No capital grant incentive scheme for low emission trucks at UK level

EC: European Commission OLEV: Office of Low Emission Vehicles TSB: Technology Strategy Board ULEZ: Ultra Low Emission Zone
TSB: Technology Strategy Board Sources: Element Energy, OLEV, DfT

elementenergy |






Figure 5 Overview of current and previous policy measures for alternatively fuelled commercial vehicles

Supply of alternatively fuelled commercial vehicles

To support conversations with interviewees, a compilation of currently or soon available AFVs was prepared. Figure 6 presents the case of gas and LPG options, while Figure 7 and Figure 8 lists the electric and hydrogen options, for vans and HGVs respectively.

In addition to the options shown in Figure 8, we are aware of at least one other electric powertrain option that is being trialled by a UK logistics organisation (public announcement expected in 2016).






EXISTING and EXPECTED GAS MODELS and LPG options

	OEMs	Converters ¹ / SMEs	Typical kW & range
BI-FUEL  <8t GVW	<ul style="list-style-type: none"> Mercedes Sprinter Iveco Daily [VW Caddy (car derived van)] 	<ul style="list-style-type: none"> Any petrol van can be converted to LPG (c. 150 accredited garages) Diesel vehicles: Mercury, Prins Autogas, Dieselgas 	<ul style="list-style-type: none"> 150 HP (110 kW) 400km on NG > 1100km total
DUAL FUEL  26-44 GVW	<ul style="list-style-type: none"> Volvo FM LNG; Volvo FH LNG (after 2016) 	<ul style="list-style-type: none"> LPG: as above Prins Autogas (MB Actros), Dieselgas (DAF XF, Iveco) Vayon², G-Volution (2016) 	<ul style="list-style-type: none"> 420-460 HP Range 500-800 km (OEMs); >1000 km (converted)
 6-26t GVW	<ul style="list-style-type: none"> Iveco Daily & Stralis & Eurocargo (2016) Mercedes Eonic Scania P Scania P & G Volvo FE CNG MAN TGM (2016) 		<ul style="list-style-type: none"> 136 - 350 HP 400km (urban) to 700km extra urban
DEDICATED  26-44 GVW	<ul style="list-style-type: none"> Iveco Stralis Mercedes Eonic Scania P & G 		<ul style="list-style-type: none"> 300 - 450 HP 800-1100 km (CNG - LNG)
 18-26 GVW	<ul style="list-style-type: none"> Mercedes Eonic Scania P Iveco Stralis Volvo FE CNG MAN TGM, Renault³ 		<ul style="list-style-type: none"> 320-340 HP 400-600 km

1 – Conversions are made on a Euro VI engine but the converted vehicle is not test approved for Euro VI again. 2 - formerly Hardstaff. 3 - Renault D Wide CNG2, not currently in the UK

Figure 6 Methane & LPG commercial vehicle models available and expected in the UK market






EXISTING and EXPECTED MODELS

		OEMs	Converters/ SMEs	Typical payload & range
RE-EVs / PHEVs		<ul style="list-style-type: none"> Mitsubishi Outlander GX3h 4Work 	<ul style="list-style-type: none"> Renault Kangoo ZE-H2 electric van with fuel cell range extender from SymbioFCCell <i>Emerald T-001 range extended van</i> 	<ul style="list-style-type: none"> 0.7t, as per diesel version (50 km in electric) REEV: 0.3t, 230 km REEV: 1.4t, as per diesel range, (100 km electric)
H2 dual fuel			<ul style="list-style-type: none"> Ford Transit by Ulemco/Revolve 	<ul style="list-style-type: none"> 0.65-1.5 t As per diesel model
Pure electric (BEV)		<ul style="list-style-type: none"> Nissan e-NV200 (cargo van) Renault Kangoo ZE Citroen Berlingo Peugeot ePartner BD OtomotiveTraffic, eDucato 		<ul style="list-style-type: none"> 0.7t 160 km
		<ul style="list-style-type: none"> BD OtomotiveTraffic, eDucato Daimler Mercedes-B Vito E-Cell Iveco Daily 		<ul style="list-style-type: none"> 0.8t 150 km
		<ul style="list-style-type: none"> BD OtomotiveDucato 		<ul style="list-style-type: none"> 1.2t 200 km

elementenergy

Figure 7 Electric and hydrogen vans available and expected on the UK market

EXISTING and EXPECTED MODELS - Europe, non exhaustive list

		OEMs	Converters / SMEs	Typical range & payload
RE-EVs	 <8t GVW		<ul style="list-style-type: none"> Tevva (Battery + EURO 6 diesel engine) [trial, sales from 2017] Renault Maxity by SymbioFCCell (battery + hydrogen fuel cell) [trial stage] 	<ul style="list-style-type: none"> 400-600 km and 2.7 t payload 200 km, 2t payload
H2 dual fuel	 18-26 GVW		<ul style="list-style-type: none"> Conversion by Ulemco/Revolve 	<ul style="list-style-type: none"> As per/very close to diesel version
Pure electric (BEV)	 <8t GVW	<ul style="list-style-type: none"> Iveco Daily (5.5t GVW) Smith Newton (7t GVW) Renault Maxity Electric (4.5t GVW) 	<ul style="list-style-type: none"> Some converters in EU, e.g. used by UPS for their London fleet 	<ul style="list-style-type: none"> c. 100 km 0.8-2.3t payload
	 8-26t GVW	<ul style="list-style-type: none"> Smith Newton (12t GVW) Ginaf (Netherlands, small volume) 12-19t GVW 	<ul style="list-style-type: none"> Some converters in EU, e.g. EMOSS & HyTruck (up to 18t) 	<ul style="list-style-type: none"> Under 160 km 0.8-8 t payload
	 26-44 GVW		<ul style="list-style-type: none"> Some converters in EU, e.g. Telberg (36t) 	<ul style="list-style-type: none"> Up to 190 km 4.5-10t

Charge (Formula-e electric truck partner) is also planning to bring out trucks in the 3.5t-26t category. See charge.auto

elementenergy

Figure 8 Electric and hydrogen trucks available and expected in Europe

Refuelling and recharging infrastructure

Maps of the current refuelling and recharging infrastructure in place in or around London have been prepared for and used during the stakeholder consultation. There are provided here for information.

The case of gas is shown below. The only public station within the London boundaries is Camden CNG station, which is able to fill light commercial vehicles up to rigid trucks. The station can be used by external fleets, but as the station has a small storage capacity, there may be a small delay for larger vehicles as the gas is compressed. An upgrade to the station to accommodate a larger fleet is being considered.

Based on discussions with relevant stakeholders as part of this research, there are at least five stations planned over the next two years in London and on key access routes, including:

- M1 North of Milton Keynes
- East of M25 corridor (two stations)
- North London
- Kent

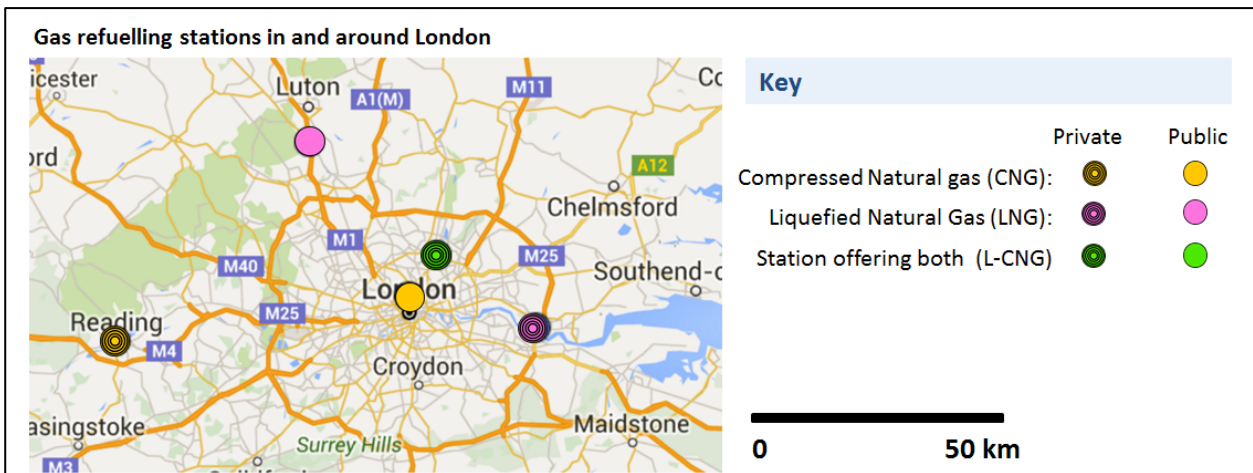


Figure 9 Gas refuelling stations in and around London as of May 2016

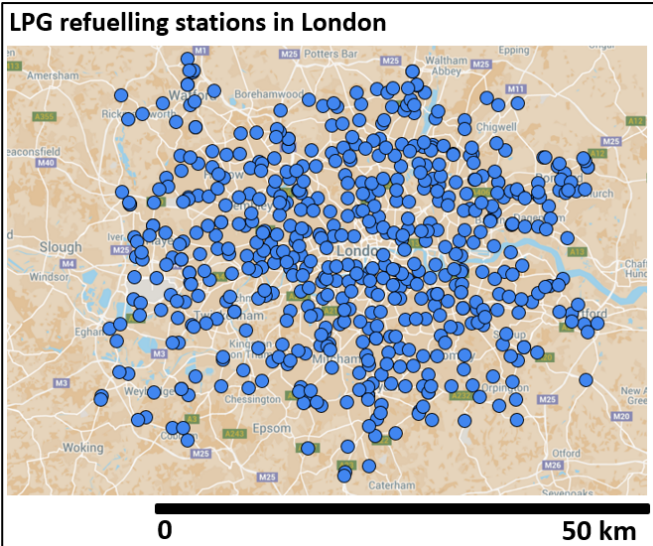


Figure 10 LPG refuelling points in and around London as of 2016. Source data: CalorGas

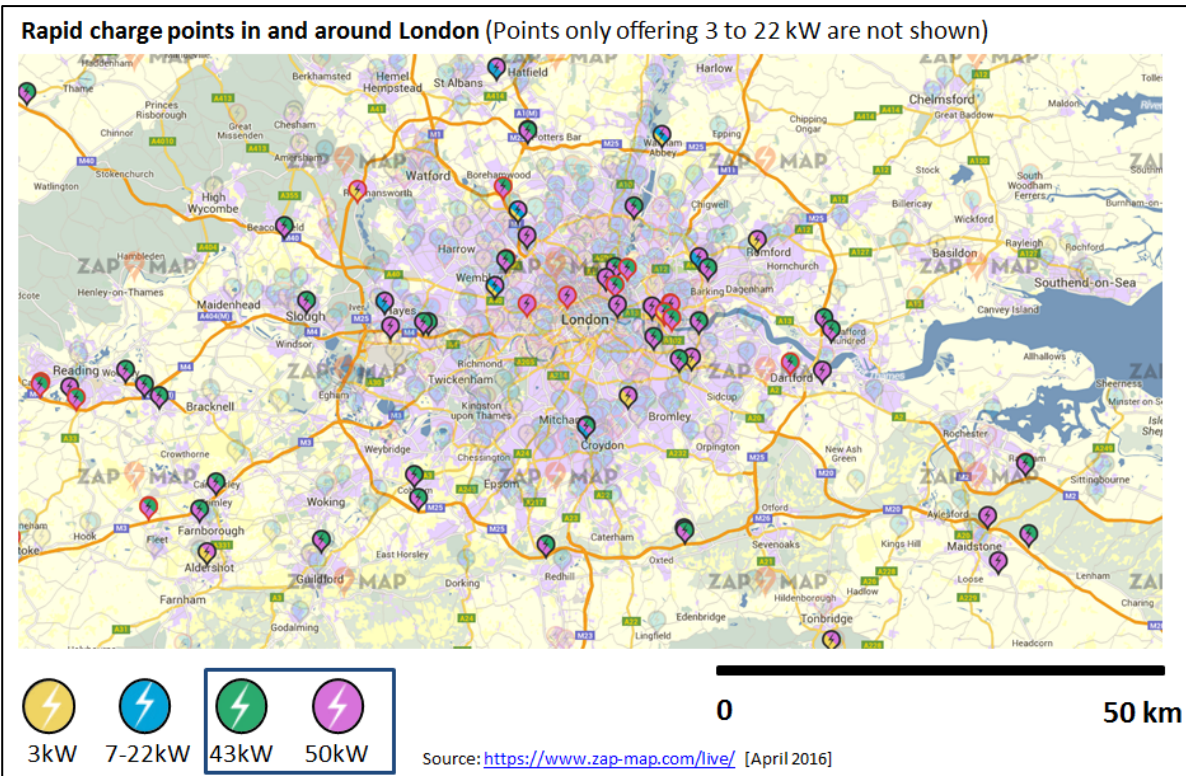


Figure 11 Rapid charge points in and around London as of April 2016

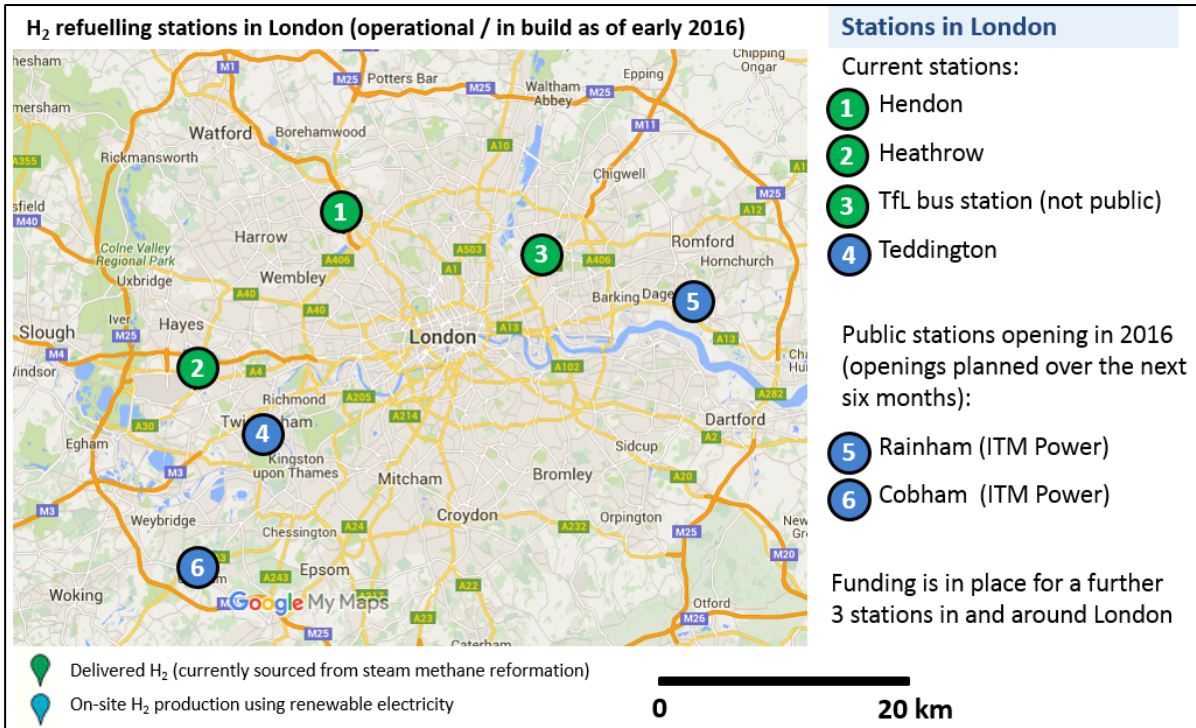


Figure 12 Hydrogen stations in and around London as of May 2016