COST BENEFIT ANALYSIS OF BIODIESEL USE IN LOCAL AUTHORITY FLEETS

A report for the Mayor's Biodiesel Programme

March 2016

MAYOR OF LONDON

Prepared for

Greater London Authority

by

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GLOSSARY

B7/B20/B30/B100 – Common terminology to reference the proportion mix of biodiesel to standard diesel within a fuel. For example, B20 contains 20% of biodiesel mixed with 80% of standard diesel.

EN 14214 - Standard published by the European Committee for Standardization specifying the requirements and test methods for Fatty Acid Methyl Ester (FAME) biodiesel. Should be used as a mandatory requirement for any procurement of biodiesel.

EN 16709:2015 – European standard that describes the requirements and test methods for B20 and B30 biodiesel. Adopted as a British Standard in October 2015 and should be used as a mandatory requirement for any procurement of B20 or B30.

EN 590 – European standard that describes the physical properties that all automotive diesel fuel must meet if it is to be sold in the European Union and within other specified European countries. Currently allows for up to 7% of volume to be derived from FAME biodiesel.

FAME - Fatty Acid Methyl Esters. A mixture of Fatty Acid Methyl Esters is commonly known as biodiesel. Non-toxic and biodegradable, with some similar physical properties to those of standard diesel. Can be derived from a number of feedstocks, including oil seeds, used cooking oil, waste animal fat and fats, oils and greases.

FOG – Fats, Oils and Greases. Can be used in the production of biodiesel, though with a need for further refinement and processing in comparison to used cooking oil. Main sources include build-up within the sewer network and waste streams from the catering and hospitality sector.

Hydrotreated Vegetable Oil (HVO) - Hydrotreating of vegetable oils or animal fats is an alternative process to the esterification process used in the production of FAME. HVO is referred to as renewable diesel rather than biodiesel and offers more chemical similarities to standard diesel, in comparison to FAME.

Original Equipment Manufacturer (OEM) – Refers to the original producer of a vehicle or a vehicle's components (e.g. the engine).

Renewable Energy Directive - Requires the EU to fulfil at least 20% of its total energy needs from renewables by 2020. All EU countries must also ensure that at least 10% of their transport fuels come from renewable sources by 2020.

Renewable Transport Fuel Certificates (RTFCs) - Any company in the UK that supplies sustainable biofuel for use in road transport or non-road mobile machinery can claim RTFCs. They can be traded or sold to companies that need them to meet their obligations under the Renewable Transport Fuel Obligation (RTFO).

Renewable Transport Fuel Obligation (RTFO) – Regulates biofuels used for transport and non-road mobile machinery. Requires that fuel suppliers must be able to show that a percentage of the fuel they supply comes from renewable and sustainable sources.

Tallow – Low cost feedstock for biodiesel production, derived from the rendering of meat products. Classified in differing degrees of quality, with differing implications for RTFCs.

Used Cooking Oil (UCO) - Waste product predominantly sourced from the catering and hospitality sector. Disposal or collection requires compliance with the appropriate environmental legislation. As a waste product it acts as a sustainable feedstock for biodiesel production.

1 EXECUTIVE SUMMARY

The Mayor's Biodiesel Programme seeks to prompt a "biodiesel revolution" in London; the ultimate aim being to turn London's used cooking oils (UCO) and fats oils and greases (FOG) into biodiesel, which can then be utilised in London - specifically by London's buses and public sector road fleet. There are multiple benefits in achieving this goal, including the following:-

- Reduction in CO_2 by up to 86%, depending on what level of biodiesel blend is used.
- Economic benefits and employment opportunities within London through the growth of a local supply chain.
- Relieving pressure on the sewer network, reducing the significant cost implications of current blockages through FOG (currently estimated at £15-20M p.a.[1]).
- Contribution to the strategy laid out in London's Transport Emissions Roadmap, which specifies a 2025 scenario for heavy duty vehicles, where 12 per cent of fleet would operate on higher blend (B20) sustainable biodiesel.

This report has been produced to assist local authority decision-makers in considering B20 uptake as a cost-effective CO_2 reduction measure. As a biodiesel blend, B20 offers no worse impact on air quality than standard diesel, whilst offering CO_2 savings with very low levels of investment in comparison to many commonly implemented environmental measures within local authorities. Biodiesel should be considered as a useful transitional fuel for the journey toward low and zero emission transport solutions. B20 fuel is readily available within London and is viewed by much of the automotive industry as an acceptable blend for fleet use.

Creating low CO_2 energy from local waste brings very clear benefits and provides London's local authorities with a simple and cost effective option as part of their carbon management strategies. The cost-benefit analysis within this report demonstrates that B20 use rates highly as a cost-effective CO_2 reduction measure for local authorities. As a transport fuel it also requires less initial investment than the other alternative fuels available to fleet managers. This is due to the minimal investment needed in infrastructure, minimal (if any) cost premium for suitable vehicles and low additional maintenance costs. B20 adoption can incur costs as low as £200 p.a. per vehicle in an additional maintenance interval, with annual fuel tank cleaning also recommend at a cost of around £750. There are also current examples of biodiesel (including B20) being provided at no cost premium to standard diesel. Table 1 below presents an overview of B20 benefits in comparison to those of other alternative fuels.

[1] Estimate provided by Thames Water, Dec 2015.

Table 1. Comparison of alternative fuels to standard diesel use

Fuel	Infrastructure cost	Vehicle cost	Fuel cost implications	Air quality impact	CO_2e savings
B20	Low	Low	Cost neutral	Negligible	10-15%
B100	Low	Low	Cost neutral	Unclear	84-95%
HVO[2]	None	None	Cost premium	Unclear	36-91%
CNG/LNG[3]	High	High	Cost savings	Positive impact	Similar
Hydrogen	High	High	Cost premium	Positive impact	100% (if renewable)
Electric	Medium	Medium	Cost savings	Positive impact	30-50%

When compared with non-fleet CO_2 reduction measures, B20 use compares well. This is again due in large part to the very low initial expenditure needed to begin use. Local authority decision-makers are encouraged to use the findings of this study to justify future B20 projects and to take advantage of the very low costs of running vehicle trials with B20. The best-case scenario within this study shows a cost-effectiveness of B20 use of £43 per tonne of CO_2 saved and this compares favourably with many common carbon reduction measures. It is also considerably lower than DECC's non-traded central scenario cost of carbon (£63/t CO_2) which is used within policy appraisals to place a cost on CO_2.

This report recommends that future local authority procurement specifications for both vehicles and any outsourced fleet services (e.g. waste contractors) include 20% biodiesel as a minimum. This will help capture low cost CO_2 savings and further stimulate the biodiesel industry by demonstrating a level of demand in London.

The greatest CO_2 savings are found when biodiesel is sourced from UCO (rather than tallow), particularly locally sourced UCO. The growing market for biodiesel in London means that the opportunity to develop a London-based UCO processing plant is becoming more viable.

There has been a historic reluctance by original equipment manufacturers (OEMs) to warranty biodiesel use within their vehicles, mainly due to fuel quality concerns. Since the introduction of European standards for biodiesel (EN 14214 and EN 16709), vehicle and engine models from a growing number of manufacturers (such as Scania, Cummins and Volvo) are now warrantied for a variety of biodiesel blends, including B20 and often higher blends. Details of what to look for when choosing vehicles and how to ensure that the biodiesel used will meet the warranty requirements are covered within this report.

In addition to the growth of vehicle and engine manufacturers accepting biodiesel use, the future potential of Hydrotreated Vegetable Oil (HVO) in heavy duty trucks

[2] Hydrotreated vegetable oil – with CO_2 savings dependant on feedstock
[3] Compressed Natural Gas/Liquified Natural Gas

was noted by all OEMs contacted within this study. This renewable fuel (produced in a different manner to biodiesel) is regarded as a "drop-in" fuel, which is functionally equivalent to standard diesel. It can therefore offer CO_2 savings without any vehicle modifications. Whilst the current cost premium and lack of availability of HVO is an obstacle, it is recommended that advancements are closely monitored and disseminated to local authority fleet managers in London.

A barrier for the rapid introduction of B20 is the historic concern over procuring fuel of a consistent quality. Since the recent introduction of the European and British standards for B20 there is evidence of expansion across the UK from some of the larger biodiesel producers, giving confidence both in terms of guaranteed fuel supply and a consistent fuel quality.

Further confidence in the growth of biodiesel use in London is provided with the recent Transport for London announcement over B20 use in the bus fleet. A third of the total 9,000 bus fleet will be running on B20 by the end of 2016, with the full fleet aiming to be utilising B20 by 2020. This provides huge confidence for biodiesel producers who can make investment decisions on processing plants with more confidence.

Thames Water have built a storage plant for Fats, Oils and Greases (FOG) in Dartford, with the aim of capturing FOG before it enters the sewage system. This is primarily aimed at reducing the substantial cost of removing build-up from the sewerage system. With enough demand, the FOG plant could be used as a source of biodiesel for the London market, meeting the circular economy aim of the wider programme.

The B20 used in London buses will lead to demonstrable CO_2 savings of around 10%[4], with no current fuel cost premium. Hackney Council has successfully utilised B100 in more than 35 vehicles, with CO_2 savings of over 500t p.a. at no cost premium for the fuel[5].

A number of London councils are now also specifying B20 use within forthcoming waste contracts, recognising that the main barriers to its use have been removed. The findings within this report show that the transitioning to a 20% blend of biodiesel should be considered a "business as usual" activity for many local authorities in London. Doing this would deliver cost competitive CO_2 reductions with little change in existing practice. Biodiesel suppliers are present on the Crown Commercial Service framework, allowing such fuel to be sourced with no additional procurement burden. The best opportunities for local authority B20 use exist where the following conditions are met:-

- On-site refuelling facilities are available for the foreseeable future.
- Current vehicles are compatible with B20 use or future vehicles can be procured which are warrantied for B20 use.
- B20 is available at no cost premium in comparison to standard diesel.

[4] Figures provided by Transport for London, Dec 2015.
[5] Figures provided by Hackney Council, Dec 2015.

- A spare fuel tank exists on-site or a fuel supplier can provide a tank at no cost, on condition of future fuel purchase.

Whilst the above provides the ideal scenario for B20 use, vehicles that are no longer in warranty can often also be switched to B20 use, with some vehicle manufacturers providing advice on the appropriate maintenance scheduling in such instances. It is recommended that all local authority heavy-duty trucks are assessed for switching to B20 adoption, where on-site depot re-fuelling is available. Biodiesel is particularly complementary within heavy-duty trucks due to the larger engines, however procurement options should also be explored within light commercial vehicles. There are current manufacturers providing warranties for use with biodiesel blends of up to B30 in vans.

There are a number of toolkit resources provided within the appendices of this report to assist with such decision-making and to aid provision of a strong business case to senior management. These should be utilised by local authorities to identify the opportunities of B20 adoption, the relevant processes to follow and the key considerations to ensure a successful project.

2 BACKGROUND TO THE MAYOR'S BIODIESEL PROGRAMME

The opportunity and potential market for utilising UCO and FOG from within London has been the focus of much previous work within the Mayor's Biodiesel Programme. This section will summarise the aims of the programme and the recent progress in stimulating the market in London, with the aim of providing confidence in the fuel to potential users. Operational notes, stakeholder workshop briefings and a study on the market for feedstock have all been undertaken through the programme. They provide useful insights and are available on the programme's web resource[6].

It is estimated that there are around 32-44 million litres of UCO waste arising in London per annum and it is this significant waste stream that is sought to be utilised in local authority fleets as a CO_2 reduction measure. By achieving the aim of the programme and stimulating waste-derived biodiesel uptake within London, the following objectives would be met:-

- Contribution to the strategy laid out in London's Transport Emissions Roadmap, which specifies a 2025 scenario for heavy duty vehicles, where 12 per cent of fleet would operate on higher blend (B20) sustainable biodiesel.
- The desire to create low carbon energy from waste, as outlined in The Mayor's Municipal Waste Management Strategy and Climate Change Mitigation and Energy Strategy.
- A reduction in business waste, as outlined in The Mayor's Business Waste Management Strategy.
- The development of new waste management infrastructure, as supported by The London Waste and Recycling Board's £73M fund.

To achieve the aims of a "biodiesel revolution" within London, a number of key actions are needed, each of which complement each other and in turn stimulate the industry. These include:-

- Local authority uptake of waste-derived B20.
- Third party waste contractor uptake of waste-derived B20.
- Widespread warranty of vehicles for B20 use by manufacturers.
- B20 to be provided by the industry at no cost premium.
- Increasing biodiesel production capacity within Greater London.

The European standards EN 16709 and EN 14214 now ensure the quality of biodiesel available on the market. This means that operators can now be confident in the use of biodiesel in their fleets, particularly at 20% and 30% blends.

Attempts at local authority use of biodiesel were made prior to the introduction of the EU standards however these have mostly been concluded, with the exception of the successful B100 project in Hackney Council. The boroughs of Richmond, Sutton and

[6] www.london.gov.uk/biodiesel

Southwark have all trialled various blends of biodiesel (at the start of the decade) but the trials were not taken forward due to a combination of reasons, which included engine problems and concern over vehicle warranties for new vehicles. For B20 and B30 blends these issues are no longer relevant and biodiesel should be revisited.

The use of B20 should be viewed as a transitional fuel and CO_2 savings can be delivered with relative ease and immediate effect, whilst technological advancements take place in other areas (e.g. HVO, hydrogen, CNG etc.). Without significant investment in both vehicles and infrastructure, heavy-duty vehicles are limited in their options for CO_2 reduction. The advantages and disadvantages of a range of alternative fuels are discussed in Chapter 4.

The key factors that need to be considered when investigating the use of B20 will be discussed in the forthcoming chapters, with the aim of providing confidence to local authorities within London. Encouragingly, progress has recently been made in a number of areas and these include the following examples.

Transport for London B20 bus adoption

December 2015 saw the announcement from TfL that almost a third of the London bus fleet will be running on B20 in 2016. This will lead to CO_2 savings of around 21,000 tonnes each year[7] and will involve the supply of B20 fuel to Stagecoach and Metroline from Argent Energy. This large-scale B20 roll-out follows significant trials by Stagecoach and is an attractive low-cost option for CO_2 reduction, due to the following:-

- No engine modification is needed and the bus manufacturers have no warranty concerns over B20 use.
- Real-life emissions testing saw no statistically significant increase in air pollutants.
- The initial trial saw no negative impact on fuel efficiency.
- The B20 fuel can currently be provided at no cost premium.
- Well-to-wheel CO_2 emissions savings are estimated at 10%, with the biodiesel production being derived from waste sources of UCO and tallow.

It is anticipated that TfL's commitment to B20 with bring confidence to the wider public sector for such alternative fuel use. This will also provide confidence for investment decisions by the biodiesel production industry, particularly as TFL's target is for all of London's diesel buses to be running on B20 by 2020.

Local authority tendering

The boroughs of Camden, Hounslow, and Westminster have all included requests for B20 options within waste contracting tenders. This will assist with awareness-raising amongst third party waste contractors and will increase pressure on such providers to consider alternative fuels. The importance of being able to demonstrate environmental credentials has, for example, led to Serco (a UK waste contractor with a number of London local authority contacts) trialling B20 use for 12 Dennis Eagle

[7] Transport for London press release, 21st December 2015

refuse trucks in Sandwell. This on-going trial saw the fuel being provided at no cost premium, with the fuel provider also covering the cost of an on-site fuel tank for the trial. There have so far been no technical issues with the vehicles and driver feedback on performance has been positive. Some concerns over a small increase in fuel consumption have been raised, however confirmation of this is awaiting further monitoring.

This project does demonstrate that B20 can be sourced at no additional cost to the contractor. This is consistent with Hackney Council's procurement of B100 at no additional cost and suggests that public sector procurement should explore the use of B20 in forthcoming contracts for outsourced fleets, as well as from current and future fuel suppliers. There are current biodiesel suppliers on the Crown Commercial Service procurement framework, which would alleviate any additional work burden in tendering for a biodiesel supplier. It is recommended that local authorities should initially explore B20 opportunities through existing fuel supply arrangements, as there are large fuel suppliers (e.g. Hall Fuels, utilising biodiesel from Regenesis) currently servicing this market.

New standard for B20/B30

The European standard for B20 and B30 (EN 16709:2015) was approved in August 2015 and specifies B20/B30 requirements for use in diesel engine vehicles designed or subsequently adapted to utilise such fuel. What this standard does is ensure consistency of any fuel that meets the specification, in terms of factors such as viscosity, sulphur content, density, water content and oxidation stability. In November 2015 The British Standards Institution approved the standard and the benefits of this will be three-fold: fleet customers can take confidence that supplied biofuel which meets the standard is of high quality; biodiesel producers have a mechanism for demonstrating the quality of their product; and vehicle and engine manufacturers have an approved fuel specification which they can now consider providing compatibility warranties for.

Evidence of cost neutrality

A number of fleet customers, both within and outside of London, have confirmed within this study that the supply of biodiesel (both B20 and B100) has been achieved at no cost premium to standard diesel. Restrictions in local authority budgets dictate that such cost neutrality will be key a factor in whether B20 uptake is adopted. With potential variances in future crude oil pricing it is impossible to state with confidence that biodiesel supply will remain cost-competitive. However, the provision of biodiesel from larger UK fuel providers demonstrates a commitment from large suppliers to cater for local authority appetite for biodiesel at no cost surplus.

Thames Water feedstock supply

Thames Water is responsible for the public water supply and waste water treatment within London. As such they are liable for the cost burden of sewer blockages and contamination from the large volume of UCO and FOG that enter the sewer system. There is therefore a clear incentive to reduce such waste pollutants and Thames Water currently offer a commercial FOG collection service. The end of Q1 in 2016 will also see them opening a FOG storage facility in Dartford, with the aim of collecting FOG, processing it and selling the resulting product to the biodiesel industry (for further processing to biodiesel standard). Whilst this product could have a number of end uses (e.g. power generation, shipping fuel and road transport) the provision of a further feedstock source within London is a very positive measure. There are also clear benefits to the circular economy through utilising this local waste at a local level and the new Thames Water storage facility could bolster the economics of a biodiesel producer potentially locating a large production plant within London.

A cost saving that can’t be quantified (but will result) will be the associated cost of sewer blockages. Thames Water place the annual cost of such work at £15M-20M p.a. and the associated flooding, public health implications, road closures and traffic disruption can all be costs that are ultimately borne by local authorities and subsequently the public purse.

The recent developments within London outlined above indicate a growing momentum in terms of increased biodiesel use. Local authorities should now seek to take advantage of this market-ready fuel. Switching to B20 not only provides cost-effective CO_2 savings, it will also help grow London’s low carbon economy and enable the city to become more energy self- sufficient.

More information on the Mayor’s Biodiesel Programme can be found at www.london.gov.uk/biodiesel.

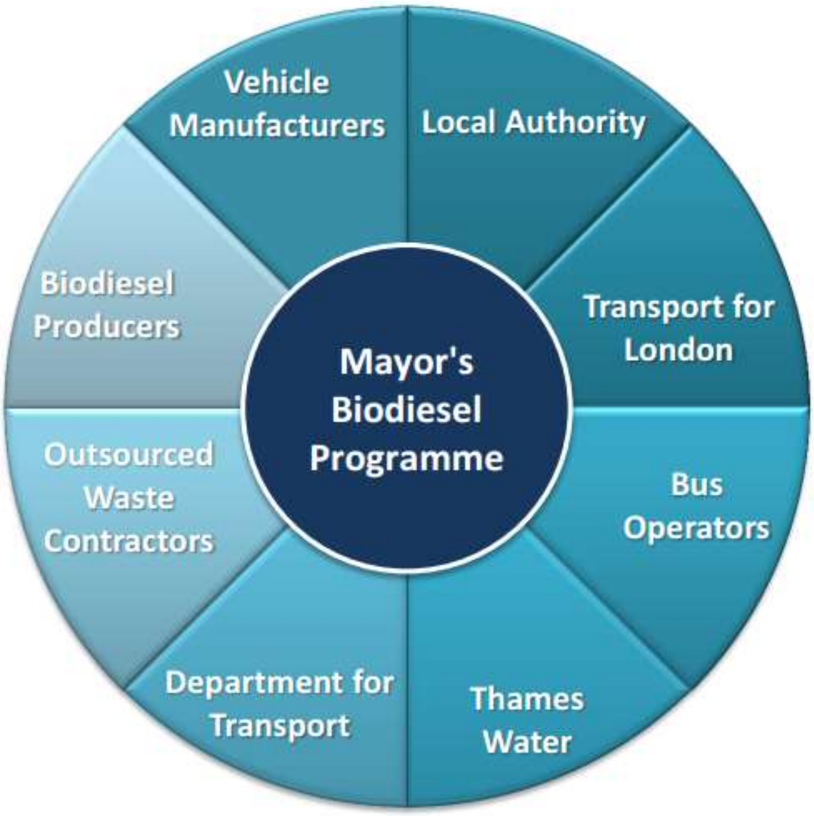
3 STAKEHOLDER ENGAGEMENT

This section will outline the stakeholder engagement which has taken place as part of the programme. This will show an industry which is relatively well developed in some areas and that with increased confidence and policy support in the right places, a big impact can be made on reducing London's CO_2 emissions. The main players to be considered in London will be outlined and their main key areas of activity have been highlighted.

Since its inception, the Mayor's Biodiesel Programme has sought to include the relevant stakeholders in discussions over stimulating the use of UCO-derived biodiesel in London. The most recent of three stakeholder workshops took place in January 2015 and brought together London's local authority fleet managers, fuel suppliers and engine manufacturers to share their experience and views over biodiesel use. As part of developing this report many of these stakeholders were interviewed.

In addition to the three key stakeholders outlined above, there are a number of key players and influencers within the Mayor's Biodiesel Programme. These are represented within Figure 1 and are further explored throughout the report.

Figure 1. Mayor's Biodiesel Programme stakeholders



The following table presents a summary of stakeholder needs and potential actions that would contribute to the continued success of the programme.

Table 2. Stakeholder assessment

Stakeholder	Key areas of action
Mayor's Biodiesel Programme	• Disseminate information on B20 to local authorities • Use influence to engage with other key stakeholders • Provide evidence of the benefits of B20 use • Monitor future industry advancement
Local Authorities (fleet managers, sustainability officers, procurement officers)	• Consider B20 use in future procurement decisions to capture CO_2 savings • Engage with vehicle manufacturers to demonstrate demand for biodiesel warranties • Uptake of B20 and provision of data results • Dissemination of information on cost-effectiveness of CO_2 reduction from B20 use to Sustainability Officers
Transport for London	• Continue to mandate the roll-out of B20 throughout the bus fleet • Engage with operators for potential results on fuel efficiency and air quality impacts • Further investigate local UCO potential
Bus operators	• Monitor B20 use and share findings • Drive demand for local biodiesel plant
Thames Water	• Growth of FOG storage facility and available feedstock, strengthening the case for a large-scale production facility in London
Department for Transport	• Monitor biodiesel data and inform GLA of future industry consultations and findings through the Low Carbon Fuels stakeholder group
Outsourced waste contractors	• Engage during local authority tender processes to seek B20 use • Meet environmental credentials within tenders
Biodiesel production industry	• Ensure fuel consistency and compliance to latest standards • Commit to production plant within London to utilise local feedstock • Provide confidence on future price volatility
Vehicle manufacturers	• Clarify current stances and simplify guidance for fleet managers • Research and seek to show compatibility with future biodiesel advancements (e.g. HVO)

3.1 Local authority fleet managers

It is acknowledged that the vast majority of local authority fleets within London are not currently using biodiesel, other than standard B7 EN590 diesel fuel. There are however both past and current examples of higher blend uptake, with successful use within Hackney Council being particularly notable. To assess the current attitudes of local authorities, a questionnaire was distributed to all 32 councils, across various fleet, waste and sustainability managers. Nine respondents completed the survey (28% of local authorities) and whilst this is a low sample size, the trends in respondents' answers give a clear indication as to current attitudes towards biodiesel use and what factors may affect future uptake.

Fleet operational targets

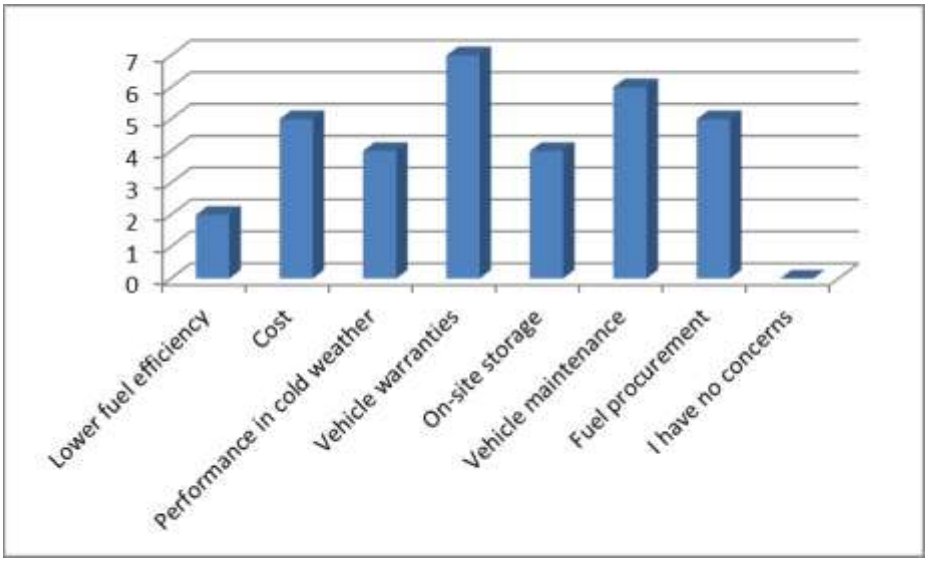
100% of respondents confirmed that they have cost reduction targets within their fleet operations, a significant point in light of any potential cost implications from biodiesel use. As referenced previously, biodiesel is currently available from some suppliers at no cost premium to standard diesel and it is clear that large-scale uptake from local authorities is unlikely if this were to change and biodiesel came with an additional cost burden.

Seven of the nine local authorities had CO_2 targets in place for their fleets. This would suggest that should biodiesel be available with no cost premium and the ability to offer CO_2 savings, there would be a very strong argument for uptake. Particularly in light of the cost premium attached to the other low-CO_2 alternative fuels discussed in Chapter 4.

Barriers to biodiesel use

Four out of nine respondents did believe that there would be a benefit in using B20 within their fleet, though it is clear from the current low use amongst local authorities that barriers do exist to widespread adoption. None of the nine local authority respondents had current plans to introduce B20 to their fleets, so it is clear that continued work is needed to stimulate uptake amongst this audience. Three local authorities are planning CNG use within their fleets. All were planning electric or plug-in hybrid adoption, though such technology would only be currently available for light commercial vehicles and cars. Respondents were asked what areas they may have concerns with, in terms of using B20 as a fuel, with answers as below.

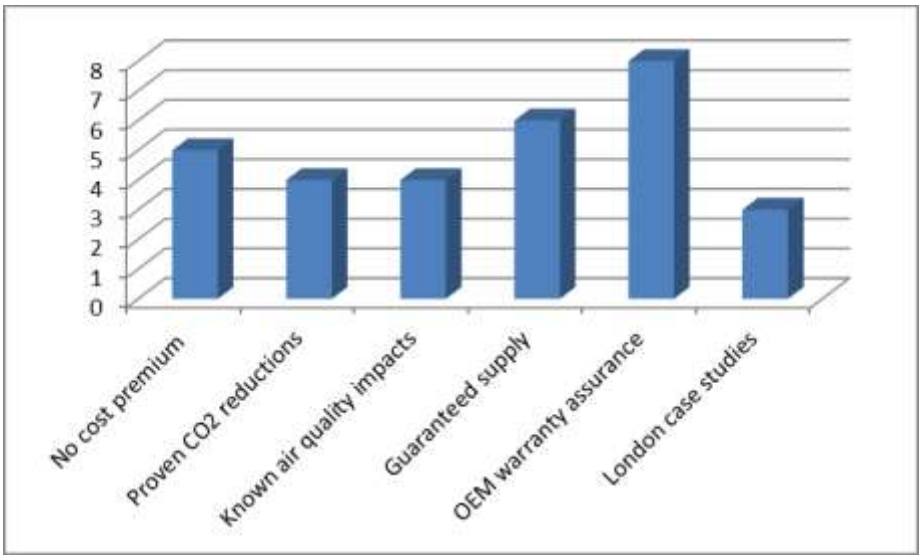
Figure 2. Local authority areas of concern with B20 use.



The results are not unexpected in terms of the primary concerns over vehicle warranties, fuel supply, maintenance and cost. There have been a number of trials of biodiesel within local authorities in London, some of which were from a number of years ago and did experience issues (e.g. fuel injector failings, camshaft issues). The legacy effect of negative experiences from some years ago may still influence some decision-makers within local authority fleets but it is important to note changes in the landscape in recent years. Notably, improvements in fuel quality as larger operators brought greater consistency of process and EU standards were introduced. In addition to this, many manufacturers are now warrantying vehicles for biodiesel use (as explored later in this section).

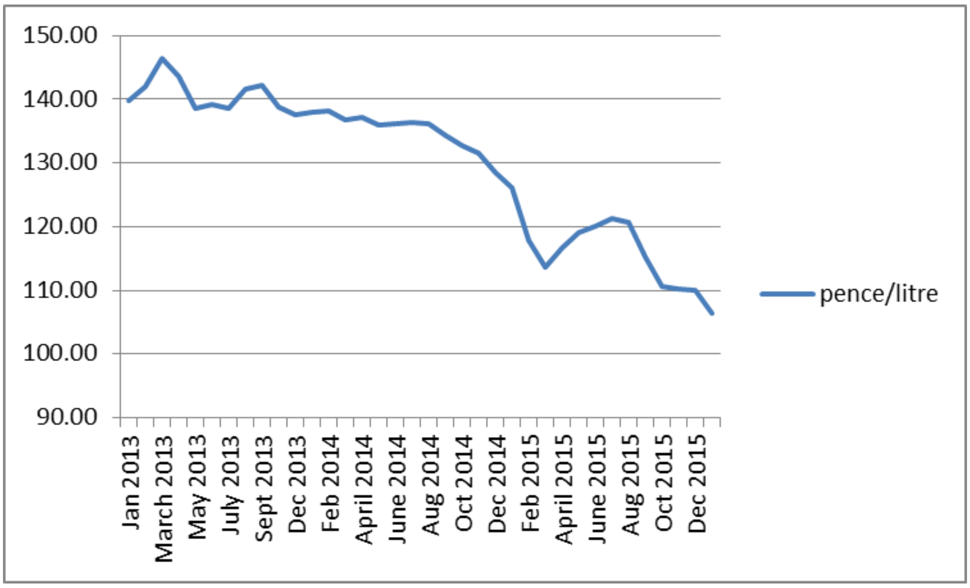
In accepting there are obstacles for B20 use, it is vital that there is clarity in the routes to overcoming those obstacles. The following factors were identified by respondents as steps that would need to be in place for them to consider B20 use. These findings should inform the focus of activity for the future GLA programme and if these obstacles can be demonstrably removed, the optimum conditions will be in place to stimulate local authority uptake. It's clear that a market providing B20 at no cost premium, through reputable suppliers with no risk to supply and with vehicle manufacturers' warranties unaffected, would ensure the maximum potential for success. It should be noted that these conditions now exist in many cases.

Figure 3. Necessary actions for local authorities to consider B20 use



We are aware that both Hackney Council and TfL are currently sourcing biodiesel at no cost premium to standard diesel, so current market conditions would seem to be in place to alleviate any concerns over biodiesel bringing with it a cost premium. There is clear volatility in the price of standard diesel however, as shown below. There is a challenge for biodiesel to compete against standard diesel prices that have been in decline for a number of years. We would urge any procurement process for B20 to ensure that conditions are included that link the price of the procured biodiesel to that for standard diesel.

Figure 4.Monthly road fuel prices for standard diesel[8]



[8] Department of Energy and Climate Change - https://www.gov.uk/government/statistical-data-sets/oil-and-petroleum-products-weekly-statistics

Within the survey, general comments were also sought from respondents. These reiterated the need for a guaranteed supply, the requirement for the fuel to be available with no cost premium and the commitment of vehicle manufacturers to support such use. More evidence that there were no negative air quality implications was also requested, along with a requirement for the fuel to come from a sustainable source (which UCO would be).

The perceived concerns from respondents over vehicle manufacturers' warranties and B20 fuel supply will be appraised over the next 2 sections.

3.2 Original equipment manufacturers (OEMs)

The longstanding concern with fleet operators' trialling high-blend biodiesel has been whether such use would void any vehicle's warranty and therefore lead to cost implications. Feedback from a number of London's local authorities that have sought such approval from vehicle/engine manufacturers has been noted. In many cases, warranty terms for their vehicle if used with B20 were difficult to obtain and were frequently inconsistent.

This lack of clarity has affected vehicle purchasing decisions and impacted upon potential CO_2 reduction objectives. The fleet manager survey carried out for this study highlights this as the key area for concern within London's local authorities. The EU Fuel Standard that currently applies (EN590) allows for a maximum of B7 to be used in all diesel vehicles without impacting on the vehicle manufacturers' warranty. As such, this is the level where any fleet operator can be confident of there being no negative implications from biodiesel use.

We engaged a number of vehicle and engine manufacturers within this study to assess their stance on biodiesel use and the results for those that responded are represented below. The list should not be viewed as exhaustive and is derived from those manufacturers that provided responses for the study.

Table 2. Vehicle/engine manufacturer biodiesel compatibility

OEM	Vehicle compatibility*	Notes
Heavy duty vehicles		
Cummins (engine provider)	ISB4.5 & ISB6.7 Euro V and Euro VI products (used within the UK bus fleet) – up to a B20 maximum.	No modification needed. Guidelines provided on operator application and maintenance.
DAF	Euro VI vehicles only currently certified to EN 590. Up to and including Euro V vehicles can be used with up to B100. Subject to caveats and modifications if 18t+.	Intend for B20 use for all Euro VI to become certified. Cummins engines used for <18t trucks.
IVECO	All current Iveco products have a limit of 7% biodiesel. Previous Euro V heavy truck engines were capable of being operated with B30 but this is no longer the case.	Euro V heavy trucks required seal modification and increase oil changes for B30 use.
Mercedes	Do not recommend the use of any diesel fuel which does not meet the EN 590 standard.	Standard diesel use only.
Scania	Offer 7 different engines ranging from 320 to 580 horse power that are certified for use with B100.	Vehicles must be ordered as FAME prepared. For reduced biodiesel mixes (e.g. B20) filters would require changing and dealer notified prior to ordering.
Volvo/Renault	Can supply the following certified to Euro VI standard with the ability to run on up to B100:- Volvo FL 10-16t (240hp) Volvo FE 18/26 t (320hp) Volvo FM/FH (460 hp) Renault D 10-16t (240hp) Renault D wide 18/26t (320hp).	Do not recommend biodiesel on existing Euro 4 and 5 truck fleet beyond EN590. Vehicles must be ordered as FAME prepared. £500-£1,000 cost premium.
Dennis Eagle	Working with Volvo to provide a Euro VI solution (320hp) to allow mixes up to B100. Expect to be able to offer this retrofit and eventually OE fitment to customers by late 2016/early 2017 with full warranty cover.	Dennis Eagle use the Volvo 7.7 Litre engine at Euro 6.
Light duty vehicles		
Citroen	All diesel vehicles warrantied for use with up to B30.	Citroën specifically markets powertrains designed to run on biodiesel for HDi diesel engines up to 30%.
Peugeot	All diesel vehicles warrantied for use with up to B30.	Peugeot specifically markets powertrains designed to run on biodiesel for HDi diesel engines up to 30%.
Vauxhall	Only EN590 compatible.	Standard diesel 7% FAME limit only.
Renault	Up to B30 permitted.	
Nissan	Only EN590 compatible.	Standard diesel 7% FAME limit only.

*Any specified compatibility assumes that the relevant EN standards have been met for biodiesel use

NB. The information above has been provided by each manufacturer. We would however strongly advise contacting your chosen manufacturer prior to any procurement to ensure that the above stances have not altered. A template for this has been provided in Appendix E should it be required.

From the above responses and extended OEM discussions, the following learnings and conclusions for fleet managers to consider when proposing B20 use are:-

- **The majority of manufacturers engaged within this study will warranty a variety of engine types for B20 use.**
- **Procuring new vehicles that are compatible with B20 use is feasible at a small (or no) cost premium**. It is essential to specify the particular biodiesel blend at the point of ordering.
- Out of warranty vehicles have previously been used by local authorities in London to trial biodiesel use at B20, B30 and B100 blends. Whilst some have been successful, **it is recommended that vehicle manufacturer assurances are gained**.
- **Some OEMs offer biodiesel warranties only for vehicles that may be above the required engine size for local authority use**. These may therefore be more expensive than the required vehicle and may have greater fuel consumption.
- In most cases, **B20 use requires a more frequent service inspection regime** than normal to monitor fuel filter conditions and for periodic oil sampling checks. However, this comes with little cost or time burden.
- The vast majority of manufacturers engaged in the study were undertaking **R & D into future HVO use**.

3.3 Biodiesel producers

A number of biodiesel producers were engaged within this study and the following narrative presents their views (where there was a clear consensus) and provides industry insight to inform future activities within the Mayor's Biodiesel Programme. In terms of recent industry moves, the following activities provide an indication of potential growth within the larger producers:-

- In 2015, Greenergy acquired Harvest Energy's biodiesel manufacturing assets, including the production plant at Seal Sands (Teeside) with a 284 million litre/yr capacity. This complements Greenergy's existing plant at Immingham, which provides a 220 million litre/yr capacity.
- Olleco (one of the UKs largest converters of UCO and food waste into renewable energy) acquired Convert2Green, a UCO collection and biodiesel production company. This increases the number of Olleco's depots across the U.K. to 17, including a plant in Middlewich, Cheshire with a capacity of 20 million litres and a plant in Bootle, Merseyside with a capacity of 16 million litres.
- Argent Energy have planned expansion beyond their current production plant in Motherwell, Scotland (with a 60 million litres/yr capacity) with a new plant under construction in Ellesmere Port. This will have a capacity of 85 million litres/yr and is due to commence production at the end of 2016.
- Regenesis have begun supply of biodiesel to Hall Fuels (a division of World Fuel Services) who are active in the provision of fuel across many London local authorities. Regenesis have production facilities at Telford (5 million litres/yr) and Ongar (12 million litres/yr).

The fundamental challenge to producers within the current climate is in attempting to provide equality in pricing with standard diesel, as prices there continue to fall. Diesel price increases would still be expected in the future and in principal that should allow biodiesel use to be a method of protecting against such rises. However, with rising diesel prices may also come rising biodiesel prices. Such pressure has already seen some smaller producers within London ceasing production as it proves more cost-effective for them to simply sell UCO to the larger biodiesel producers in the market. The cost of labour, energy consumption, processing and quality control testing for each batch is prohibitive in comparison to the large producers' costs per litre.

Despite the fall in cost of standard diesel, we are aware of a number of examples (in and outside of London) where biodiesel blends are being provided at no cost premium to standard diesel. With increasing budget restrictions amongst local authorities this cost neutrality is fundamental. Little evidence is available to provide any projections over the future price volatility of biodiesel, however we would strongly advise any future local authority procurement of biodiesel to have future pricing linked to costings for standard diesel. In this way, confidence can be provided that use of biodiesel will not bring any on-going cost implications.

In terms of the viability of future production facilities within London, clearly the land, labour and rates costs associated with the city will have a major bearing on the profitability of any plant. In addition, there needs to be a consistent volume of raw material feedstock, which brings with it an element of risk. Research undertaken by the Greater London Authority estimates that London and the South East produces around 70 million litres of UCO per year - enough to meet London's buses and local authority fleet fuel needs at a B20 blend.

It is estimated by the biodiesel suppliers engaged in this study that an appropriately sized production facility in London (to meet London's future potential local authority fleet needs) could cost in excess of £15M and therefore confidence would be needed that future demand will present itself. Local or national governmental support could help stimulate such a move and would augment the incentives already in place through the Renewable Transport Fuel Certificates.

The stakeholder views provided within this section show that there are areas of concern amongst local authorities with regard to biodiesel use. Many of those concerns can however be alleviated with the growing progress in manufacturers warrantying vehicles for biodiesel use. Coupled with this is the ability for the provision of fuel to a consistent, high-quality standard now that European standards have been introduced. With these previous restrictions lifted, biodiesel use should be considered wherever feasible.

4 COST-BENEFIT ANALYSIS

The need to gain the best possible value within public sector spending is an ever-present requirement and the emphasis on cost-effectiveness has increased following the global financial crisis. As such, it is clear that any investment decisions need to be taken from a fully informed standpoint, both to minimise risk and to ensure best spend of the public purse. This section will investigate the cost effectiveness of B20 use as a CO_2 reduction measure, in comparison to other alternative fuels. It will also review B20 use in comparison to other non-transport CO_2 reduction measures often employed by local authority energy and carbon management teams. Placing a financial value on the environmental benefits of B20 use will be completed in line with best practice guidance from the Treasury Green Book. The Green Book provides techniques and issues to be considered when assessing all new policies, programmes and projects within public sector spending.

4.1 Methodology

The Treasury guidance makes it clear that all new projects should be subject to comprehensive but proportionate assessment. The comparatively low value of investment necessary for B20 adoption should be considered when judging the level of assessment appropriate for its use.

A traditional cost-benefit analysis would place a monetary value on the financial benefits to be achieved through the project and demonstrate a return on investment that would be used to justify capital and operational expenditure. This would be consistent with the methodology used to assess the cost effectiveness of many common local authority fleet measures, e.g. telematics use, eco-driver training, best-in-class vehicle purchase etc. It should be noted however that B20 use does not offer a payback period for any initial or on-going investment.

In terms of the specified benefits, as covered in previous chapters, CO_2 savings are the key benefit and it should be stressed that these can be achieved at a relatively low cost. As such, B20 use will be compared with standard diesel, whilst attaching a monetary value to the CO_2 savings from its use. The figure used for comparison is £63 per tonne of CO_2 avoided. This figure is derived from DECC's non-traded central scenario cost of carbon, as published in the Green Book supplementary guidance[9]. This guidance provides analysts with valuations of energy use and greenhouse gas emissions for appraisal purpose and is thus fit for use within the purpose of this study.

[9] Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal, DECC 2015.

4.2 Overview of costs and benefits

The baseline for the comparison of B20 will be diesel use (with on-site bunkered fuel) within local authority fleets. The potential cost implications of B20 use are as follows.

Table 3. B20 project costs

Cost item	Factors	Cost range	Cost frequency
New bunded fuel tank/dispenser	Dependant on capacity. Can also be hired or potentially provided *gratis* by fuel supplier	0-£5,000	One-off
Tank cleaning	Best practice for an annual clean compared to every 2-3 years for standard diesel tanks	£750 p.a.	Annual
Vehicle modification	Some new vehicles come with a small premium for biodiesel modifications	0-£1,000	One-off
Vehicle sizing	Some manufacturers only warrant B20 use for vehicles above the normal engine size needed by council fleets	£0-£8,000	One-off
Additional annual servicing	Noted as best practice	£200-£250 per vehicle p.a.	Annual
Fuel cost	Can potentially be sourced with no cost premium	Variable	Annual
Increased fuel consumption	Not proven as an issue and unlikely to lead to additional costs	0-£520 per vehicle p.a.*	Annual
Fuel sampling	Unlikely to be necessary unless there are quality issues	0-£240 p.a.	Annual

*Cost based on max 5% increase in fuel consumption.

The wide ranges above will clearly impact on the cost-effectiveness of any B20 project and so each local authority will need to individually assess their circumstances. The Green Book guidance recommends that a range of options should be created and reviewed within any project, to help set the parameters on a given solution. For the purposes of this section we will consider two options for B20 adoption, with differing project costs.

<u>Best-case scenario (Scenario 1)</u>

This assumes the following conditions:-

- No additional cost for a separate B20 tank (either provided gratis by fuel supplier or using an existing on-site tank).
- Either using current vehicles or procuring new vehicles that come with no cost premium (or have no need) for modification to allow B20 use.
- The supply of B20 at no cost premium to standard diesel.
- No change in fuel consumption through B20 use.
- No fuel quality issues and therefore no sampling requirements.

Scenario 1 can be seen as realistic and has been detailed from information provided by current biodiesel operators. Within this scenario there are only annual costs for tank cleaning and additional vehicle servicing. **At the lower range this equates to £750 p.a. for tank cleaning and £200-250 p.a. per vehicle for an additional maintenance service.**

Additional cost scenario (Scenario 2)

This assumes the following conditions:-

- A need to purchase a new 10,000 litre bunded tank with fuel dispensing system (c. £5,000).
- A fuel cost premium of an additional 5%.
- Vehicle cost premium of £500 per vehicle.

In Scenario 2, base start-up costs are £5,000 and an additional £500 per vehicle, with annual projected base costs of £750 (tank cleaning) and an additional £720 p.a. per vehicle[10].

With both the scenarios above, any expenditure on fuel tanks and tank cleaning can become minimal costs per vehicle should large-scale adoption be undertaken.

For the purposes of this example analysis, CO_2 savings will be considered for B20 use in comparison to standard diesel use in a total of 50 refuse collection vehicles within a local authority's fleet, with an average annual fuel use of 12,989 litres per vehicle[11]. This volume of fuel for each vehicle has tank-to-wheel CO_2e emissions of 33.562t, with B20 use offering a 15% saving on this, equating to 5.034t CO_2e per vehicle p.a.[12] Tank-to-wheel emissions are being used as it is these Scope 1 tailpipe emissions[13] that local authorities will report on, rather than well-to-wheel figures that encompass the CO_2 impact from refining, distribution etc.

Tank-to-wheel CO_2 emissions for B100 are zero, as 100% biodiesel is classed as "carbon neutral" as any CO_2 expelled during the burning of the fuel is cancelled out by the CO_2 absorbed by the feedstock used to produce the fuel during growth. When CO_2 equivalent (CO_2e) is considered, this incorporates N_2O and CH_4 which are tailpipe biodiesel emissions. These greenhouse gas emissions are presented as the equivalent value in terms of $CO_{2.}$ CO_2e will be the focus of this example analysis for B20.

In considering a value-for-money assessment of B20 uptake, a comparison should be made to compare the costs of the project against 'do nothing' and 'do minimum' approaches. For both of these, the comparison can be seen to be maintaining the use of standard diesel. The below table presents the costs for B20 use across 50 new Refuse Collection Vehicles (RCVs as detailed in Scenario 1 above and in line with Treasury Green Book cost-benefit analysis guidance.

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[10] Includes cost of maintenance and additional fuel costs. Based on refuse collection vehicle with 3.5 MPG average fuel consumption, annual 10,000 miles p.a .and standard diesel price of 80p/l exc. VAT.

[11] Using the average MPG and mileage estimated from Logistics Carbon Working Group, 2012

[12] Calculations made using Defra Carbon Conversion Factors - the carbon reporting protocol used within UK local authorities. Assumes current standard diesel biofuel content of 4.75%, in line with RTFO guidance.

[13] Following Greenhouse Gas Protocol guidance

Table 4. Cost benefit analysis of B20 use (Scenario 1)

B20 factors	Year									
	0	1	2	3	4	5	6	7	8	9
Costs										
Maintenance	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Tank cleaning	750	750	0	750	750	0	750	750	0	750
TOTAL	**10,750**	**10,750**	**10,000**	**10,750**	**10,750**	**10,000**	**10,750**	**10,750**	**10,000**	**10,750**
Additional benefits										
CO2 savings*	15,587	15,587	15,587	15,587	15,587	15,587	15,587	15,587	15,587	15,587
Net cost	**-4,837**	**-4,837**	**-5,587**	**-4,837**	**-4,837**	**-5,587**	**-4,837**	**-4,837**	**-5,587**	**-4,837**
Net Present Value (3.5%)**	**-4,837**	**-4,671**	**-5,216**	**-4,363**	**-4,215**	**-4,704**	**-3,935**	**-3,802**	**-4,243**	**-3,549**

*Using a CO_2 price of £63/t CO_2 and an average 5.034t saving p.a. per vehicle. Included for information but not used to calculate the £/t CO_2 abatement figure given below.
**The discount rate is used to convert all costs and benefits to 'present values', so that they can be compared if required.

In the above example the cost per tonne of CO_2e saved is derived from the combined maintenance and tank cleaning costs, divided by the potential CO_2e savings of 251.7t across the 50 vehicles. In the first 12 months this is £42.71 (without deduction of CO_2 price). It is this figure (and those for future years) that should be considered by local authorities when assessing the benefit of B20 use in comparison to other common CO_2 reduction measures. This figures compares very favourably with the DECC value for non-traded carbon in 2016 (£63).

If the cost per tonne of CO_2 saved from any project is less than this DECC value for non-traded carbon, then the project can be said to offer good value for money on an environmental basis. In this case the business cost ratio is below 1 (0.68) and therefore investment in the project would be justified.

In addition to the above, Scenario 2 pricing is detailed below, incorporating further costs as outlined in Table 5.1.

Table 5. Cost benefit analysis of B20 use (Scenario 2)

B20 factors	Year									
	0	1	2	3	4	5	6	7	8	9
Costs										
Maintainence	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Tank cleaning	750	750	0	750	750	0	750	750	0	750
Tank cost	5,000	0	0	0	0	0	0	0	0	0
Fuel cost premium	26,000	26,000	26,000	26,000	26,000	26,000	26,000	26,000	26,000	26,000
Vehicle cost	25,000	0	0	0	0	0	0	0	0	0
TOTAL	**66,750**	**36,750**	**36,000**	**36,750**	**36,750**	**36,000**	**36,750**	**36,750**	**36,000**	**36,750**
Additional benefits										
CO_2 savings	15,587	15,587	15,587	15,587	15,587	15,587	15,587	15,587	15,587	15,587
Net cost	**51,163**	**21,163**	**20,413**	**21,163**	**21,163**	**20,413**	**21,163**	**21,163**	**20,413**	**21,163**
Net Present Value (3.5%)	**51,163**	**20,447**	**19,056**	**19,088**	**18,442**	**17,187**	**17,216**	**16,634**	**15,502**	**15,528**

NB. The above assumes a 5% fuel cost premium and a £500 additional cost for B20 new vehicle modification.

In the above example the cost per tonne of CO_2 saved is £265.20 in the first 12 months, reducing to £146.01 in the following year.

As is evident from the above, there is a large variance in the cost of B20 uptake, dependant on the conditions in which the fuel is introduced. Whilst B20 use would be recommended in Scenario 1 detailed above, it may be less favourable (though could still be considered) to do so under Scenario 2.

The potential cost implications and benefits of diesel and other relevant alternative fuels are considered below. Further biodiesel information is also provided to expand on the above.

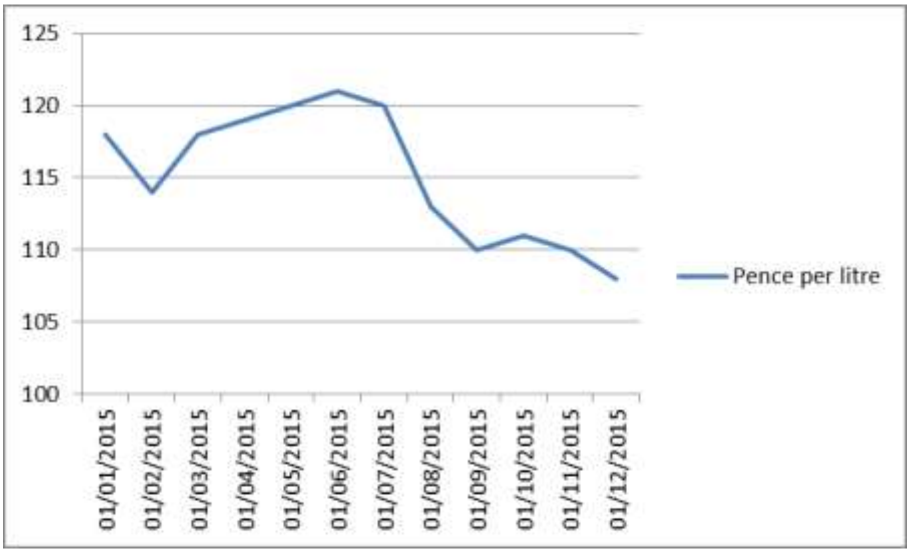
4.3 Standard diesel

Diesel fuel (gasoil) is a globally traded product that meets British Standard EN590 specification. Therefore it is subject to the supply/demand balances of the global economy. Its base price is also directly correlated to the price of crude oil, however its ultimate selling price can be affected by shortages of supply. The EU refineries can only produce around 55-65% of European diesel demand and therefore the EU has to import finished diesel to balance the demand required.

Fuel cost

Over the last two years the price of crude has steadily fallen due to various economic and political effects around the globe. As of January 2016 crude has dropped below $30 per barrel, which equates to an ex refinery price for diesel of just 18p/l.

Figure 5. Diesel price trends (2015)[14]



[14] DECC, Digest of UK Energy Statistics (DUKES), 2015

The full cost breakdown of diesel is as follows[15]:-

Base Fuel Price (ex refinery)	:	18.00 p/l
Delivery	:	2.00 p/l
Wholesaler margin	:	3.00 p/l
Fuel Duty*	:	57.95 p/l
Pre VAT Price:		**80.95 p/l**

Infrastructure cost

For fleets with on-site refuelling, diesel is stored in bunded tanks, with dispensing pumps that generally have a data collection system that allows vehicle identification (e.g. registration or fleet number) and monitoring of the fuel volume dispensed with mileage entry. This infrastructure will be already in place for local authorities with on-site refuelling and therefore for the purposes of this comparison, there is no additional cost associated with the use of diesel.

CO_2 impact

For the purposes of this study, Defra carbon conversion factors will be used for diesel (as the accepted national standard for such reporting of standard fuels).

Tank-to-wheel emissions = 2,583.90g CO_{2e}/litre
Well-to-wheel emissions = 3,165.00g CO_{2e}/litre

Air quality

Diesel fuel is a major source of both Particulate Matter and NO_x emissions, both of which (as referenced in Chapter 3) are known to lead to health issues amongst the population. Each update of the EU Emission standards relating to diesel has set tighter and lower emission levels of both these pollutants and therefore improvements should be evident within the vehicle fleet with regards to these emissions. However in reality this has not been the case.

The underperformance of emission control systems that are standard on Euro IV, V and VI diesel vehicles is due to the differences in operation between the test programme and real life use. The testing regime at a manufacturer (EU) level requires the engines to be tested on their own (i.e. not in a vehicle and without gearboxes and axles etc.) and no 'real life' road type testing is carried out to validate these 'engine out' emissions levels. Recent roadside testing in Sheffield[16] has determined that in real life, congested stop-start operations, the Selective Catalytic Reduction (de-NO_x) equipment is severely underperforming. For example, results on buses showed that a Euro V single deck bus was emitting higher NO_x than existing Euro III buses and that double deck Euro V buses were on a par for NO_x emissions with a Euro II double deck bus. Whilst no specific work was done on refuse collection

[15] Derived from HMRC, Excise Duty – Hydrocarbon Oil Rates, 2015 https://www.gov.uk/government/publications/rates-and-allowances-excise-duty-hydrocarbon-oils/excise-duty-hydrocarbon-oils-rates

[16] Vehicle Emission Measurement and Analysis - Sheffield City Council, Dr James Tate, University of Leeds

vehicles (RCVs) it is evident that the reasons for the shortcomings will apply equally, if not to a greater extent, to RCVs.

It is important to note that whilst real life performance of commercial vehicles at a Euro VI level appears to be close to the lab test results, these reports are for typical HGV work over a variety of driving cycles. No certainty is yet available as to how Euro VI performs in very slow speed work. There has been limited real world Portable Emissions Monitoring System (PEMS) test work done (though this is now being undertaken) and specifically for an urban or RCV drive cycle, where the above issues may well continue to manifest themselves, despite the best intent of the vehicle/engine manufacturers.

4.4 Comparison of alternative fuels

The following section focusses on a number of alternative fuels that are available as options for local authority fleet managers. Fuel cost, infrastructure cost and CO_2 implications will be analysed to allow for a final comparison of B20 with standard diesel and other alternative fuels. A summary comparison of these factors is set out in Table 6 on page 38 of this report. The calculation methodology for CO_2 emissions is as follows:-

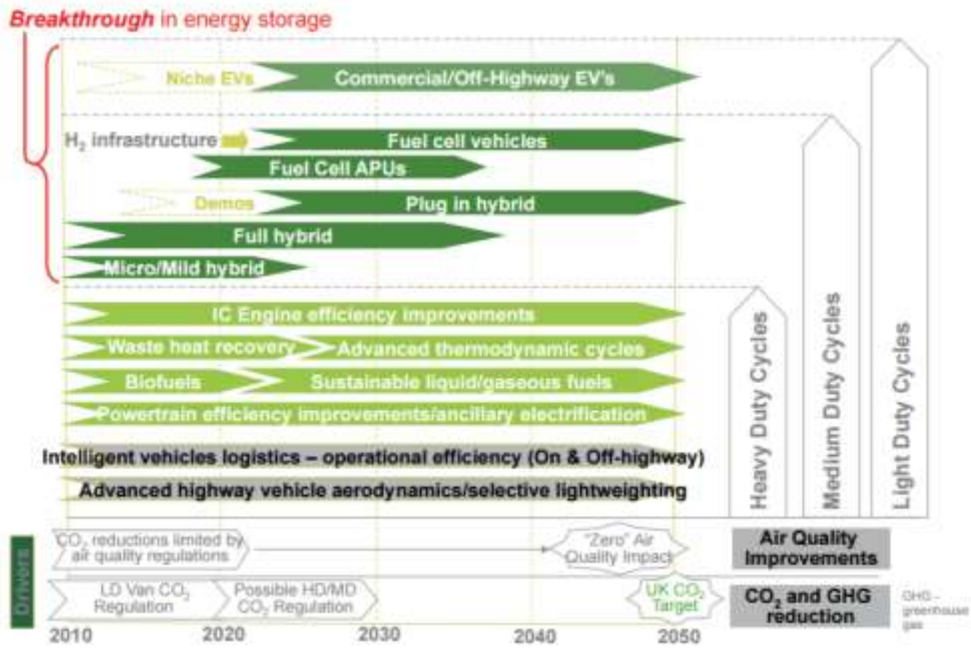
- For biodiesel blends and other fuels, Defra Carbon Conversion Factors will be used as they reflect the UK's nationally recognised carbon accounting protocol. As such, they are used by local authorities for CO_2 reporting.
- For alternative fuels not available through the above, figures will be derived from a joint council comprising the EU Joint Research Council, Concawe (the European oil industry body for the environment) and EUCAR (the EU R&D body for automotive manufacturers). This peer reviewed dataset is found in the report entitled 'Well-to-Tank Appendix 2 - Version 4a - Summary of energy and GHG balance of individual pathways (Report Version 4a, April 2014)."[17]

This section provides an overview of individual alternative fuels and associated cost and CO_2 implications. Conclusive direct comparison values in terms of potential project costs and CO_2 impact are out of the scope of the study, due to the many complexities and variables involved for any one fuel (e.g. differing grant assistance with infrastructure, the potential for shared re-fuelling facilities, large variances in scale of refuelling options, engine efficiencies).

In addition to individually detailing the characteristics of a range of alternative fuels, the figure below presents an insight into the timeframes for market maturity and highlights the current market-readiness of biodiesel use.

[17] http://iet.jrc.ec.europa.eu/about-jec/sites/iet.jrc.ec.europa.eu.about-jec/files/documents/report_2014/wtt_appendix_2_v4a.pdf

Figure 6. Commercial vehicle technology roadmap[18]



4.4.1 Biodiesel

The benefits of B20 use and the aims of stimulating uptake in London have been covered previously and the detail below is provided for consistency with that provided for other alternative fuels.

Fuel cost

Biodiesel fuel is also a globally traded product that meets a set EN14214 specification. Therefore it is subject to the supply/demand balances of the global economy of countries that have legally binding targets for renewable fuels. There are two feedstock sources for biodiesel production – waste oil streams and crop derived virgin oils.

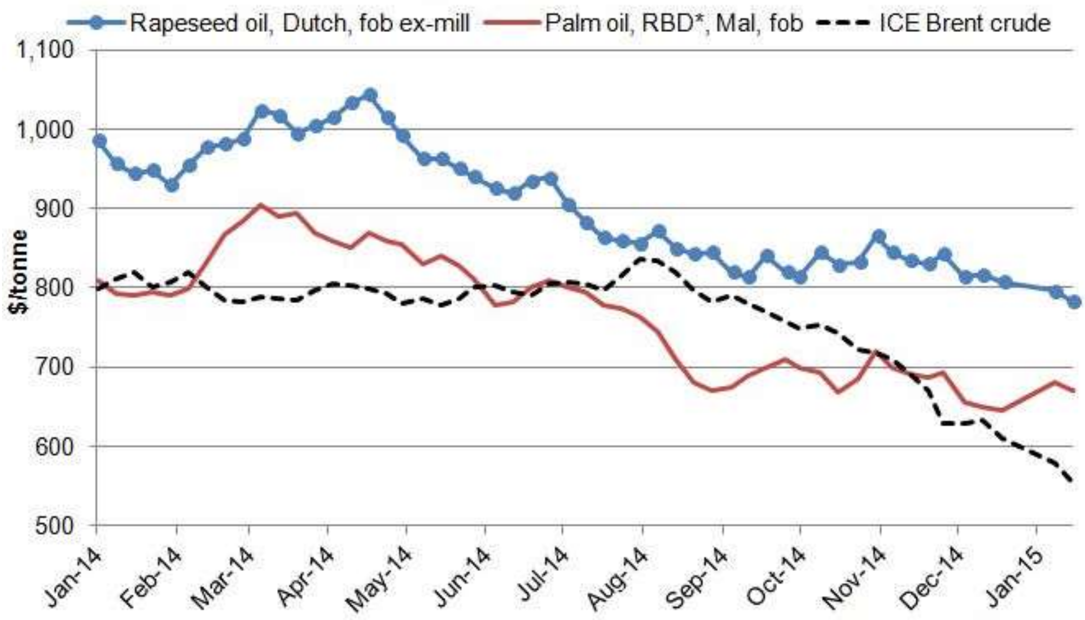
Biodiesel is made by a catalytic trans-esterification process (a chemical reaction) to convert the oil into a diesel type molecular structure using methanol. The resultant fuel is a Fatty Acid Methyl Ester (FAME). However to control the specification requires careful manufacturing controls. Quality of the end product is directly correlated to the care and attention of manufacturing, as well as the consistency of the raw material used. The best fuel is produced when a further distillation step is introduced to enable tighter control of the final oil.

Crop based raw oils such as palm, rapeseed etc. have an intrinsic commercial value due to their alternative use as virgin cooking oils or as a food additive.

[18] Automotive Council Technology Group, 2012

Their value is dependent on the amount of crops grown in any one year and the supply/demand balances. The graph below shows that the price has been falling over the last 4 years. $800/tonne equates to 51p/litre.

Figure 7. Vegetable oil and crude oil prices[19]



Used cooking oil, tallow, and other 'waste' fats, oils and greases also command a price for their conversion to biodiesel and this fluctuates in relation to the price of virgin cooking oils. Waste oil collectors advise that in Jan 2016 they can command an average price of 35p/l (depending on quality).

The processing costs, from industry discussions will add a further 20-25p/l to cover chemicals, overheads and a small profit.

The finished biodiesel has a traded price (in Rotterdam) which currently (Jan 2016) is around $450/t higher than standard EN590 diesel. That equates to about 30p/l higher cost. Therefore at present for the major suppliers of fuels it costs more to include biodiesel in their fuels.

However, biodiesel produced in the UK to a tightly controlled sustainability requirement gets a Renewable Transport Fuel Certificate for every litre produced (or 2 certificates if it is produced from a waste stream). These certificates have a commercial value as they can be sold to the major fuel companies in order for them to meet the obligation placed on them under the RTFO.

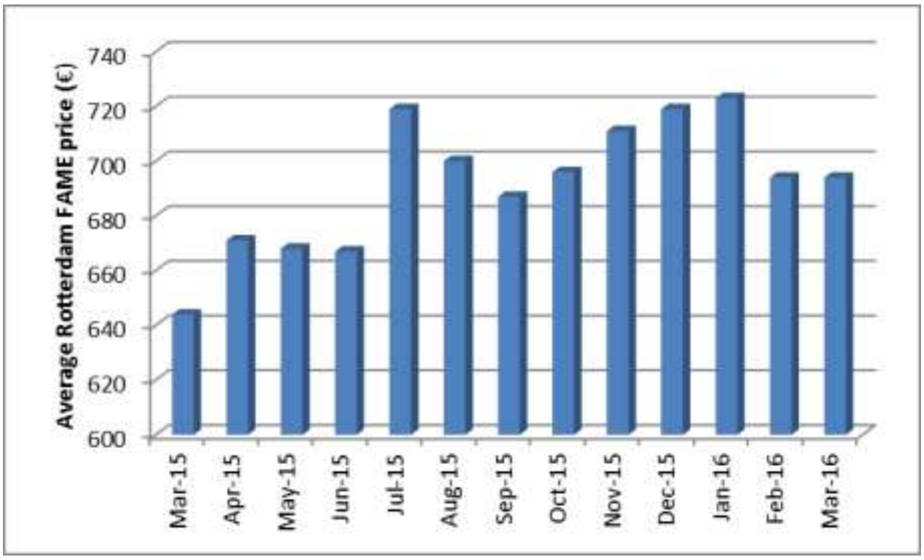
The current (Jan 2016) value of the certificate is in the order of 20p/l and therefore, for the supply of a B20 fuel, this is helping offset the price differential and enables the fuel to be sold at around the same price as conventional diesel. The price of these certificates correlates to the differential between the price of conventional diesel and biodiesel. As the prices converge so the value of the certificate reduces.

[19] Derived from Oil World, AHDB/HGCA

Fuel supply companies can pay a 'buy out' price in lieu of providing certificates for the biodiesel they have put in their fuel. This buy-out price at the time this report was published was 30p/l

Below is a graph showing the traded price of FAME biodiesel over 2015. As can be seen its price is not affected by the fall in crude oil prices.

Figure 8. FAME biodiesel pricing[20]



For the purposes of this study, B20 will be attributed no cost premium over standard diesel. This is in line with current available bulk prices as advised by a number of suppliers and customers engaged within this study.

Infrastructure costs

For fleets with on-site refuelling facilities, biodiesel blends can be stored in existing bunded tanks with associated dispensing pumps that generally have a data collection system that allows vehicle identification (e.g. registration or fleet number) and monitoring of the volume of fuel dispensed with mileage entry. Local authority fleets may already have such spare units on site. Should an extra storage tank be needed for B20 fuel then the fuel supplier will likely supply this free of charge in return for an offtake agreement.

Good housekeeping is required as the 'bio' element of biodiesel can allow moisture absorption, bug growth and oxidation if turnover of use is not well structured. A clean out of the tank before initial fill is strongly recommended. Likewise, an annual tank clean is recommended, in comparison to current practice with standard diesel tanks, which may be cleaned every 2-3 years.

[20] Derived from Argus monthly average price for FAME -10 fob ARA. This biodiesel is RED compliant.

Whilst not strictly an infrastructure cost, there will be additional costs incurred as biodiesel use requires a more frequent service inspection regime than normal to monitor fuel filter conditions and for periodic oil sampling checks.

Fuel tank costs = £0-£5,000
Tank cleaning cost = £750 p.a.
Additional maintenance = £200-£250 p.a. per vehicle

Vehicle cost

As has been mentioned, there will be variances in any additional vehicle costs for biodiesel use. At the lower end of the scale there may be no cost premium for a vehicle compatible with B20 use and this will be the case if current vehicles are used with no modification necessary. However, in other scenarios cost may be incurred for engine modification (c. £500-£1,000) or costs may also be incurred by B20 compatible vehicles only being available in larger engine sizes than those they are replacing.

CO_2 impact

For the purposes of this study, Defra Carbon Conversion factors have been used to provide tank-to-wheel CO_2e emissions for biodiesel use. Through these figures, B20 offers a 15% saving in comparison to standard diesel[21]. Whilst CO_2e figures are also available through the RTFO statistics, these are solely well-to-wheel and so fall outside the scope of standard local authority CO_2 reporting.

What is however of interest to note is RTFO insight into the differing well-to-wheel emissions of biodiesel from UCO and that sourced from a tallow feedstock. Whilst B100 from tallow is attributed with a 84% CO_2e saving, UCO-derived biodiesel offers and improved 86% saving. Using the RTFO figures, B20 from UCO would offer a 13% CO_2e saving in comparison to standard diesel.

This further strengthens the benefits of sourcing UCO-derived biodiesel, along with the wider benefits previously discussed where local feedstock is utilised.

Other items of note for any end user of biodiesel are as follows:-

- There are some pump filters (installed to protect dispensing pumps from debris coming from the storage tank and pipes) that are better suited to use with biodiesel than others. These should be installed where possible and biodiesel supplier views sought at the point of purchase.
- Fuel filter changes need to be monitored to ensure blockages are minimised if microbial growth takes place.
- Anti-microbial products can be added to the biodiesel to stop growth in both storage and more importantly fuel tanks that can lead to fuel filter blockages.

[21] Assuming a current 4.75% of biofuel content in standard diesel – this target is obligated on fuel suppliers through the RTFO.

- Fuel tanks, fuel lines and all components up to the fuel injectors should be cleaned prior to biodiesel use.

Fuel consumption

Conclusive evidence is not available on the impact of B20 use on fuel consumption. As such, any trial would be recommended to include MPG monitoring of vehicles, both prior to and during the use of B20. The energy content of B20 is 35.4MJ/litre compared to that of 36MJ/litre for standard diesel and this would suggest a very minimal impact at worst. B100 has an energy content of 33 MJ/litre which would suggest a likelihood of an increase in fuel consumption, although again, real-life evidence is inconclusive. Hackney Council, for example has not reported any fuel consumption concerns when running B100.

4.4.2 Hydrotreated Vegetable Oil (HVO)

The potential obstacles to wider uptake of waste-derived biodiesel (e.g. vehicle warranties and increased maintenance scheduling) and the views of local authority fleet managers towards these are covered in previous chapters. Of the many vehicle/engine manufacturers engaged within the study, there was not always consistency across warrantying current vehicles for B20 use. However, what was consistent was the interest and current research from them into the potential future use of Hydrotreated Vegetable Oil (HVO) in their vehicles. The feedstock for this fuel can be crop-based or from waste products (e.g. UCO and FOG) with the advantage of offering a very consistent fuel quality regardless of the feedstock.

HVO is produced in the process of hydrogenation, i.e. treatment with hydrogen. At a simple level, in comparison to traditional biodiesel production the HVO process uses hydrogen (rather than methanol) as the catalyst[22]. The advantages to HVO use compared to biodiesel are as follows:-

- Less chance of fuel degradation as oxygen is removed from the fuel
- Lower quality feedstock can be used
- Superior energy density
- Potential air quality benefits (though as yet unquantified)
- Less liable to waxing in extreme temperatures (HVO has a low cloud point and high octane number, enabling vehicles to function under severe cold climates and providing clean combustion conditions).
- Chemically similar to EN590 standard diesel, so in principal requiring no engine modification or changes to maintenance schedules for additional filter changes, tank cleansing etc.
- Engine performance and torque data are thought to remain the same when HVO is used[23].

[22] Is HVO the Holy Grail of the world biodiesel market, GreenEA 2015
[23] Daimler Press Release, 22nd February 2016

Thanks to zero aromatics, reasonable distillation range, low density and high cetane number, HVO can be seen to be a superior blending component than biodiesel. The storage stability of HVO is also good, without any need for a "use before" date. HVO is a valuable component for oil refineries since it enhances practically all properties of base diesel fuel. An area where FAME is better is that it can replace lubricity additive which has to be used in all high quality hydrocarbon fuels.

From the above, HVO can be seen to have many attractive properties and UCO and FOG use as a feedstock is still feasible, with comparable CO_2 savings. Like biodiesel, HVO is considered within the Renewable Transport Fuel Obligation (RTFO), receiving 1 RTFC per litre of fuel, or 2 RTFCs if the fuel is produced from a double-counting material (e.g. waste material such as UCO/FOG)[24].

Fuel cost

There is little transparency over current pricing, however it may be that HVO is currently cost prohibitive for local authority consideration. This is mainly due to the expensive production process involving hydrogen. It is however strongly recommended that this market is closely monitored and that any progress in competitive pricing is communicated to local authority fleet managers. Recent anecdotal evidence (March 2016) has suggested the willingness of HVO suppliers to capture custom within London, though even if offered at a loss (to stimulate the market) it is thought there would be at least a 3-5p/litre cost premium to standard diesel.

Infrastructure cost

There are no additional tanks or pumps required for HVO as it can be used as a "drop in" fuel. This is a strong attraction in addition to the lack of need for any additional maintenance scheduling.

Vehicle cost

No modifications are required for HVO use and hence no cost premium for suitable vehicles. As discussed, vehicle manufacturers are strongly focussing on HVO research. As an indication of progress, Mercedes-Benz has recently warrantied a number of trucks in North America for HVO use without any modification.

CO_2 impact

CO_2 figures for HVO are not available from Defra or provided within RTFO guidance. As such, figures from the aforementioned EU Joint Research Council/CONCAWE report will be used for illustrative purposes. This gives a CO_2e saving (in comparison to standard diesel) of 91% where UCO is the feedstock and 72% should tallow be used. A 36-58% saving would be achieved with a variety of differing crop-based feedstocks, though with the caveat over potential concerns on the sustainability of such feedstock.

[24] RTFO Guidance Consultation for Year 8: April 2015 to April 2016, DfT

As with biodiesel, the key to maximising CO_2 savings is the use of waste products as a feedstock. Unlike with biodiesel there is not currently any UK producers of HVO and thus ensuring a locally derived UCO feedstock would not be feasible.

Additional information

Neste Oil are currently seen as the market leader in the provision of HVO, with three processing plants in Finland, Singapore and Holland[25]. Global production capacity of HVO is estimated at 3.5m tonnes, with Neste accounting for 2.5m tonnes of this[26]. Neste have advised that historically, HVO was mainly crop-based and now contains around 64% of waste products. Key to meeting the aims within London would be increasing this percentage of waste products to ensure the maximum CO_2 savings.

Of encouragement to the long-term potential of this fuel are the recent announcements by major energy companies of new HVO activity. TOTAL have recently confirmed a 200M euro investment to transform the Le Mede oil refinery into France's first biorefinery[27] and ENI made a 2014 move to convert its Venice refinery into an HVO production facility.

As fuel, HVO is a little lighter than diesel and due to such differing densities it doesn't fall within the EN590 specification for standard diesel. Hence the need for manufacturers to explore warrantying vehicles for specific HVO use. There is a European standard under development (EN15940) which will cover paraffinic diesel from synthesis or hydrotreatment and such progress will ensure consistency across the industry and provide further confidence for vehicle manufacturers.

Until such time as cost for HVO reduces to a similar level as biodiesel, it is biodiesel products that will continue to offer the most cost-effective CO_2 reduction potential to local authorities in London. The high costs of HVO relate to the expensive production process and it is unproven whether an increase in demand and future economies of scale will lead to lower pricing.

4.4.3 Natural Gas (LNG & CNG)

Natural gas use (particularly in heavy-duty trucks) is far more prevalent in other regions (e.g. North America) and can be a cost-competitive and cleaner fuel for heavy-duty road transport in comparison to diesel. Natural gas use in vehicles needs to be split into two options – Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG). With CNG, gas is compressed directly from the UK's underground pipelines, the Natural Gas Grid Network. This enables locations to be chosen that allow for the siting of the refuelling station alongside the pipeline and thus negates any road deliveries of fuel.

With LNG this requires the liquefaction of natural gas by cooling to -162 degrees C and this liquid is then thermally stored as such. Between 20% and 40% of the total gas used in the UK arrives in tankers as a liquid. This can be directly pumped into an

[25] European Biofuels Technology Platform - http://www.biofuelstp.eu/hvo.html

[26] Information provided by Neste, Jan 2016

[27] TOTAL press release, 2015 - http://www.total.com/en/media/news/press-releases/totals-french-refining-roadmap-upgrade-donges-and-transform-la-mede

insulated tanker, which then pumps into insulated storage tanks from which it can be pumped into insulated fuel tanks on trucks.

The notable factors around natural gas use are explored below.

Fuel cost

Natural Gas (both compressed and liquefied), like diesel, is a globally traded product. For Europe, the UK's National Balance Point price determines the general price for grid-fed natural gas. Liquefied Natural Gas (LNG) is traded on the Rotterdam market and for the UK it supplements the direct North Sea Gas fields and the Norwegian gas pipelines. The UK does not take gas from Russian pipelines. The UK exports gas through the European Gas Pipe interconnector – this is LNG that is landed in the UK, gasified, and then sent into Europe.

Natural gas is sold as a vehicle fuel in kg and in dual fuel trucks 1kg of fuel is likely to displace around 1.4litres of diesel[28], giving clear cost benefits. Natural Gas pricing is now independent of crude oil as the volumes of natural gas available have grown significantly with the advent of USA Shale reserves, and the growth of global LNG shipping. Typical sales prices of CNG in Jan 2016 are 73p/kg whilst LNG is higher at around 90p/kg[29].

Infrastructure cost

The UK has two tanker loading terminals where LNG can be dispensed into road tankers – the Isle of Grain (Kent) and Avonmouth Terminal (Bristol). However the Avonmouth facility is due to be decommissioned soon. LNG can be imported by road tanker from the Netherlands, Spain, and Denmark.

The infrastructure required to set up a CNG refuelling station that could refuel up to 200 vehicles per day would cost in the region of **£1.5m** to build. An LNG refuelling facility to do the same would cost in the region of **£900,000** depending on the storage tanks sizing.

Any organisation considering the large-scale introduction of natural gas use should seek discussions with fuel suppliers as various agreements may be available over infrastructure costs being absorbed by the supplier, for guaranteed supply orders.

Vehicle cost

Vehicle availability for dedicated natural gas is well established. There are 3 models of RCVs available from Mercedes-Benz, Volvo and Scania. Dedicated CNG vans are available from Mercedes-Benz and Iveco and dedicated buses (single and double deck) are available from ADL/Scania and MAN.

The additional cost of the vehicles compared to a Euro VI diesel vehicle are estimated as follows:

[28] Derived from energy equivalency calculations
[29] Sourced from known operators

RCVs **£25,000**
Buses **£28,000**
Vans **£ 2,500**

These figures do not include any potential volume discount.

CO_2 impact

Natural Gas is a traditional fossil fuel whose carbon footprint is dependent on its ultimate source. Biomethane is made in the UK from the anaerobic digestion of organic materials from food waste, sewage, manure and surplus crop wastes. This is injected into the gas grid and has an effectively zero carbon footprint. Whilst a purchaser of grid natural gas can't ensure that biomethane is the ultimate source, they can buy green gas certificates which ensure that they are then responsible for an equal amount of biomethane entering the grid.

LNG has a higher CO_2 footprint than CNG due to the energy used to liquefy it at source, transport it to the UK and then the emissions from road delivery. Within the engine it is important to minimise any methane 'bleed' from the engine by using tight fuel control and in some cases a methane catalyst in the exhaust.

The below comparator uses the Defra Carbon Conversion factors:-

Tank-to-wheel emissions

CNG	2,726.05g CO_2 per kg
LNG	2,726.05g CO_2 per kg
Biomethane	0 CO_2 per kg

Natural gas vehicles can be promoted for CO_2 savings if green gas certificates are purchased, if not the CO_2 savings are minimal, with the above figures comparing to diesel tank-to-wheel emissions of 2,583.90g CO_{2e}/litre. Comparisons of differing fuel types can be aggregated into energy equivalents (e.g. CO_2e/MJ). It should however be noted that differing fuel engine types deliver differing efficiency losses and therefore true comparisons should only be made within specific vehicle types under consideration.

Air quality

Dedicated CNG/LNG trucks, buses and vans produce low levels of NO_x and virtually no PM due to the nature of spark ignition engines. They do not need the complicated after-treatment systems required for diesel engines to achieve Euro VI emission standards.

Without any real world drive cycle emissions testing it is not possible to draw conclusions on the real world emissions of gas trucks compared to diesel trucks. Such results will however be available later in 2016, due to testing with London's LoCity project.

The lack of any after-treatment system means the vehicles are easier to maintain and are consistent in their performance no matter what the drive cycle is. They are also quieter than diesel engines emitting around half the noise levels.

4.4.4 Hydrogen

Hydrogen vehicles remain a niche technology, with little UK adoption that has not been subsidised by the state or industry. It is however a fuel that can offer significant greenhouse gas emission savings, if produced from renewable sources. With no exhaust emissions they also have the potential to offer significant air quality benefits.

Fuel cost

Hydrogen fuel pricing is dependent on its source of production. There are two principal production routes – steam reformation of natural gas (fossil) and the electrolysis of water using renewable electricity.

Steam reformation of natural gas is used in oil refineries to produce hydrogen for the hydrogenation units used to modify crude oil products. Hydrogen can be generated from natural gas with approximately 80% efficiency. The production of hydrogen from natural gas is currently the cheapest source of hydrogen. This process consists of heating the gas in the presence of steam and a nickel catalyst. The resulting exothermic reaction breaks up the methane molecules and forms carbon monoxide and hydrogen. The carbon monoxide gas can then be passed with steam over iron oxide or other oxides and undergo a water-gas shift reaction. This last reaction produces additional hydrogen. The downside to this process is that its major by-products are CO, CO_2 and other greenhouse gasses. Depending on the quality of the feedstock (natural gas, rich gases, naphtha, etc.), one ton of hydrogen produced will also produce 9 to 12 tons of CO_2. The vast majority of hydrogen produced in the UK is by this method.

Electrolysis consists in using electricity to split water into hydrogen and oxygen. This source of hydrogen is by far the most expensive since the energy input required for water splitting is higher than the energy that could be obtained from the produced hydrogen. With the objective of reducing the cost of hydrogen production, renewable sources of energy have been targeted to allow electrolysis.

The cost to produce Hydrogen also falls into two price categories depending on the production route. Steam reformation hydrogen typically sells for around £6/kg and renewable (electrolysis) hydrogen sells for around £11/kg. Hydrogen currently pays no fuel duty. Longer term, the price of renewable hydrogen is expected to fall to below £5/kg (again without any fuel duty).

The latest fuel cell buses use around 9.8kg of hydrogen per 100km, which is £0.94 per mile with hydrogen at £6/kg (steam reformed) or £1.72 per mile with hydrogen at £11/kg (renewable). Diesel at 7 mpg and 83p/l is £0.54 per mile.[30]

Infrastructure cost

[30] Sourced from ITM statement for renewable hydrogen via electrolysis and for steam reformation delivered by trucks.

Hydrogen is transported as compressed hydrogen in tube trailers (900kg @ 500bar) and can then either be decanted from the trailer into storage on the customer site or for larger demands the trailer can be left on site and the customer can draw directly from the storage. The TfL station below has onsite storage of 350kg @ 500bar.
For vehicle refuelling it can be supplied as a compressed gas at either 350bar or 700bar pressures.

Refuelling 32kg onto a London Bus takes between 10-13 minutes. The estimated cost of the above TfL installation (including two tube trailers) is **around £750,000**. Currently the cost of a solar powered hydrogen production and refuelling station capable of dispensing 60kg per day is around £1m.

Vehicle cost

Vehicle availability for dedicated hydrogen fuel cell vehicles is in its early commercial phase. There are 3 models of cars available from Honda, Toyota, and Hyundai. Dedicated (single deck) buses are available from Van Hool and Mercedes Benz.

The additional cost of the vehicles compared to a Euro VI diesel are:

Cars	**£30-50,000**
Buses	**£460,000**

CO_2 impact

This comparator uses the EU data generated by the EUCAR/ Concawe/ JRC 2015 report "Well-to-Tank Appendix 2 - Version 4a - Summary of energy and GHG balance of individual pathways[31]."

Well-to-tank emissions are provided below for indicative purposes as tank-to-wheel emissions are regarded as zero within the report, i.e. there are no tailpipe emissions.

[31] Fully peer reviewed report from a joint council comprising the EU Joint Research Council, Concawe (the European oil industry body for the environment) and EUCAR (the EU R&D body for automotive manufacturers).

EU Natural gas Mix	113.1 g CO_{2eq}/MJ
Electrolysis (Wind)	13.0 g CO_{2eq}/MJ
Electrolysis (EU Mix Electricity)	254.4g CO_{2eq}/MJ

EU Natural Gas Mix WTT footprint is	13,752g CO_2 per kg
Electrolysis (Wind) WTT footprint is	1,560g CO_2 per kg
Electrolysis (EU Mix Electricity) WTT footprint is	30,528g CO_2 per kg

4.4.5 Electric

Electric vehicles currently remain a cost-effective solution within certain scenarios and certain vehicle types. These would typically be for cars or light commercial vans travelling between 40-70 miles per day. Technology of a size above that of light commercial vans is available, though with a bigger cost premium than found with smaller vehicles. With no exhaust emissions they have the potential to offer significant air quality benefits.

Fuel cost

One of the key advantages of electric vehicles is the low running costs, which ensure that maximising mileages (within the available battery range) will deliver notable cost savings. The below costings are derived from DECC's "Gas and electricity prices in the non-domestic sector" dataset, which provides the average electricity tariff figure of 10p/kWh for large non-domestic users. These are combined with consumption figures for the Nissan Leaf and Nissan e-NV200 van for illustrative purposes.

Nissan Leaf= 150Wh/km = 1.5p/km = **2.4p/mile**
Nissan e-NV200= 165 Wh/km = 1.65p/km = **2.65p/mile**

Infrastructure cost

Electricity distribution is well established in the UK. Recharging points for vehicles will need to be installed on-site and depending on the number of vehicles and the amount of electricity used there may need to be local transmission upgrading putting in place. However each installation has a level of uniqueness so there is no definitive pricing model. Full detail of London's public recharging network can be found at www.zap-map.com. Vehicles can in principle be charged from standard 13amp 3-pin sockets (though a dedicated circuit would be recommended) however to benefit from faster charging a 32amp chargepoint would be recommended. A basic, wall-mounted unit would start from £800 fully installed but costs rise sharply should smart communications (e.g. RFID card access) be required or if ground mounted units are needed.

Should rapid charging facilities be needed (allowing charging to 80% within 30 minutes) installed costs would begin at £15,000.

Vehicle costs

The approximate additional cost of electric vehicles compared to a Euro VI diesel are as follows (including government grant):

Cars	**£ 5-15,000**	Vans	**£5-15,000**
Buses	**£75-100,000**	Trucks	**£50-75,000**

CO_2 impact

There are a variety of electric vehicles of differing sizes, with differing levels of electricity consumption per km (and hence CO_2/km). For illustrative purposes, the figures below have again been provided for the Nissan Leaf car and Nissan e-NV200 van.

Nissan Leaf= 75g/km CO_2e
Nissan e-NV200= 83g/km CO_2e

These figures compare very favourably with the average new car in the UK (125g/km[32]) and average new van (169g/km[33]).

CONCLUSION

There are clearly a number of alternative fuel options available to local authority fleets, with differing advantages, disadvantages and associated costs. The cost of on-site refuelling depots for hydrogen and natural gas options would be viewed as prohibitive by most local authorities, however funding streams and engagement with fuel suppliers may allow realistic opportunities for such projects. There may also be options available in terms of shared refuelling infrastructure with neighbouring organisations. There are however, still large cost premiums for the vehicles themselves.

Within each fuel type there are many variables in terms of vehicle types, level of infrastructure needs and wide ranges of potential project costs dependant on scale. What is evident is that B20 use allows for the lowest start-up costs in terms of both infrastructure and vehicle investment. Whilst there are no on-going savings in terms of running costs, if fuel can be sourced at no cost premium to standard diesel (of which there is evidence) then the on-going costs are minimal to achieve notable CO_2 savings. A summary of the cost-benefit analysis in this Chapter is set out in Table 5 below.

[32] SMMT, New Car CO_2 Report, 2015
[33] 2014 figure sourced from the European Commission - http://ec.europa.eu/clima/policies/transport/vehicles/vans/index_en.htm

Table 6. Alternative fuel overview

Fuel	Infrastructure cost	Vehicle cost	Fuel cost implications	Air quality impact	CO_2e savings
B20	Low	Low	Cost neutral	Negligible	10-15%
B100	Low	Low	Cost neutral	Unclear	84-95%
HVO	None	None	Cost premium	Unclear	36-91%*
CNG/LNG	High	High	Cost savings	Positive impact	Similar**
Hydrogen	High	High	Cost premium	Positive impact	100% (if renewable)
Electric	Medium	Medium	Cost savings	Positive impact	30-50%

*Dependent on feedstock
**c. 90% CO_2e savings from biomethane if green gas certificates are purchased.

Due to the low capital expenditure needed for both vehicles and infrastructure, it is unlikely that potential B20 uptake is competing with other alternative fuels in terms of pure investment decisions. With the recent progress in introducing European standards for B20, concerns over the technical issues experienced historically by some local authority fleets in London should be alleviated. Confidence can be taken from many of the advancements previously discussed, the new standards and increasing OEM commitment to biodiesel use in their vehicles.

4.5 Comparison to non-fleet CO_2 reduction measures

There are many competing CO_2 reduction measures across the public sector, all with differing characteristics and formed to deliver on individual local authority CO_2 management plans. To inform of where B20 uptake may rank within this raft of measures, this section will detail a range of common measures and the expected outputs in terms of cost effectiveness.

It should be noted that biodiesel can also be used in gensets for renewable energy generation. Whilst energy generation scenarios are outside the scope for this study, there are many examples where biodiesel is a cost effective option, albeit with typically lower CO_2 saving benefits compared with transport applications. One example is Uptown Oil, a London-based biodiesel producer supplying Price Waterhouse Coopers (PWC) with 100% UCO biodiesel. This is used in an onsite tri-generator in PWC offices on the More London estate near Tower Bridge. More information can be found at https://vimeo.com/29806824.

In a sample of five of London's local authorities reviewed within this study, the contribution of fleet activities to the councils' overall carbon footprint ranged between 5.9% and 17%[34]. The other services with a noted contribution included the below:-

- Corporate Property
- Housing Stock

[34] Informed from a review of the Carbon Management Plans of Barking, Bromley, Enfield, Tower Hamlets and Sutton.

- Schools
- Leisure Centres
- Streetlights
- Staff Business Travel
- Contractors
- Passenger Transport
- Water

Whilst fleet transport is referenced in all the carbon management plans reviewed for this study, it's notable that there is further potential for integration between corporate fleet policies and carbon management plans. Such a move could strengthen the visibility of fleet activities across senior management. Of the local authorities reviewed, the following overall targets were in place.

Table 7. Local authority CO_2 reduction targets

Local authority	CO_2 reduction target	Timeframe
Barking	20%	2011/12-2015/16
Bromley	15%	2013/14-2017/18
Enfield	40%	2008-2020
Tower Hamlets	60%	2007-2020
Sutton	40%	2010-2017

To achieve such targets, a wide range of effective measures will be needed and these will vary widely in terms of capital and operational costs, payback periods, the need for grant or loan finance and the achievable level of CO_2 savings. Equally, there will be a variance in terms of CO_2 abatement costs depending on factors such as project timeframe, project location and whether contracted parties have been awarded tenders weighted on best price or with more emphasis on quality.

In comparing B20 use to non-fleet CO_2 reduction measures, it is not appropriate for the comparison to be based on payback periods. Unlike energy efficiency schemes, biodiesel use will not offer a financial payback. What it does offer is a low cost route to CO_2 savings, which will be demonstrated in this section. The comparisons in this section will be based on the cost per tonne of CO_2 saved and for B20, the scenario used in the previous section will continue: B20 use across a fleet of 50 RCVs, with on-site refuelling and fuel being procured at no cost premium to standard diesel. This scenario presents a potential cost of £43 per tonne of CO_2 saved.

In assessing common local authority energy efficiency measures, existing carbon management plans have been reviewed for a number of London's local authorities. These provide expenditure figures and CO_2 savings for a wide variety of historic projects, as well as for planned and potential future projects. Figures are presented below, with reference to the cost effectiveness of B20 uptake. An average 15-year lifespan has been used across all measures (unless lifespan has been informed from other research) to calculate cost-effectiveness figures based purely on capital expenditure and annual CO_2 savings. The findings should be used for comparisons of carbon reduction measures in terms of initial capital expenditure related to CO_2 savings, rather than an on-going financial payback comparison. Whilst the measures below cover those within the reviewed carbon management plans, there will also be other measures available to local authorities that have not been specified.

Table 8. Cost-effectiveness of local authority non-domestic energy efficiency projects

Measure	Cost effectiveness (£/t CO_2)
Smart metering	16
Power down equipment	27
HVAC controls	30
B20 use	**43**
Thermostatic radiator valves	43
Heating controls	44
Voltage optimisation	47
Replacement high efficiency burners	55
Variable speed drives	55
School loft insulation	61
Boiler optimisation	62
Lighting sensors	64
Street light replacement	73
Lighting upgrade	76
Efficient hand driers	104
Draught proofing	117
LPG to natural gas conversion	117
Double glazing	182
Boiler replacement	203
Pipe insulation	214
Biomass CHP	245
Ground source heat pump	430
Solar PV	880

The above projects are provided for illustrative purposes and it should be noted that each project will be distinct in terms of its individual characteristics. For example, the cost of installing voltage optimisation equipment in one location (and the accompanying CO_2 savings) can vary widely. It should also be noted that the energy efficiency projects will have varying payback periods but will all provide a return on the initial investment. The advantage that B20 use brings is the low capital expenditure needed in the best-case scenario in comparison to the start-up costs for many of the measures above, which can require significant initial investment.

This section demonstrates the cost-effectiveness of B20 use and its ability to deliver CO_2 savings at a comparatively low initial cost to many of the common energy efficiency measures implemented by local authorities. A number of London's local authority plans are due for renewal in 2016/17 and it is recommended that information on B20 use is distributed to the appropriate contacts for consideration. It can then be appraised alongside other CO_2 reduction measures and complement wider CO_2 reduction strategies.

4.6 Building a business case

2015 supplementary Green Book guidance focusses on using the "five-case model" to construct an effective business case for spending proposals[35]. Whilst again such work should be proportionate to the size of the project, the following section will provide an overview of the business case for B20 use, in the context of the model suggested by HM Treasury. It is provided to assist with local authority project proposals to senior management and provides a high-level overview of the arguments for biodiesel use. A stand-alone version for fleet manager use is provided in Appendix B.

It is also noted that the Public Services (Social Value) Act 2012 requires commissioners to include social value when considering public service contracts. Under this legislation, local authority commissioners must now consider how they can improve the social impact of their public service contracts before they start the procurement process. Whilst cost is increasingly the main driver in local authority procurement, the environmental impacts and local benefits of biodiesel use should be considered within any business case.

The Strategic Case

Fundamental to the strategic case for B20 use is the low-cost CO_2 reduction that its use offers. CO_2 reduction requirements are driven at EU, UK and regional level by the following:-

- EU Renewable Energy Objective - 10% of final energy consumption in the transport sector must come from renewables by 2020. Each Member State has an individual target within RED and the UK's target for heat, transport and power is for 15%[36].
- UK Climate Change Act 2008 – Target to reduce UK's greenhouse gas emissions by at least 80% (from the 1990 baseline) by 2050. 2020 target of 20% reduction compared to the 1990 baseline.
- Contribution to the strategy laid out in London's Transport Emissions Roadmap, which specifies a 2025 scenario for heavy duty vehicles, where 12% of fleet would operate on higher blend (B20) sustainable biodiesel
- Each individual council has a Carbon Management Plan which sets out CO_2 reduction targets. Examples of which can be seen in Chapter 5.5.
- The Mayor's Energy for London target of 25% of London's energy need to come from local renewable sources by 2025.

[35] Green Book Supplementary Guidance on Delivering Public Value from Spending Proposals, 2015, HM Treasury.
[36] Climate Change Legislation in the EU, Committee on Climate Change - https://www.theccc.org.uk/tackling-climate-change/the-legal-landscape/european-union-legislation/

Maintaining the status quo in terms of local authority fleet operations will fail to produce the necessary CO_2 reductions. Much of the "low hanging fruit" in terms of fleet CO_2 savings (e.g. telematics, good fuel management, driver training etc.) have already been implemented and to achieve further savings, alternative fuels need to be adopted. Of these alternative fuels, B20 can be easy to implement and cost-effective.

All of London's local authority fleets engaged within this study have cost reduction targets and whilst B20 use will not lead to cost savings, in best-case scenarios it can be adopted for a notional additional cost of around £200 per vehicle p.a. (the cost of an additional annual service/filters/oil change) and an annual £750 fuel storage tank cleaning cost.

The Economic Case

Within the Green Book methodology there is a need to demonstrate that the spending proposal (in this case for biodiesel use) optimises public value. The cost-benefit analysis provided in Chapter 5.2 demonstrates that B20 use has strong potential as a cost effective CO_2 reduction measure, should the appropriate conditions exist. With a best-case cost effectiveness of £43/t CO_2, further comparisons are shown in Chapter 4.5 which demonstrate that B20 compares favourably with many common energy efficiency measure frequently employed by local authorities within London.

The Commercial Case

Planning and management of the procurement needs within a B20 project will be catered for within current processes. Both fuel suppliers and vehicle suppliers are currently procured through a competitive tender process, with only minor specification changes needed to include B20 use. It is recommended that fuel pricing within B20 procurement is linked to crude oil pricing where possible and that vehicle procurement does not favour larger engine vehicles (which may be more likely to be warrantied for B20 use but may come with a cost premium and increased fuel consumption). It is advised that the recommendations within London Councils' Best Practice Guide on Vehicle Acquisition are followed to ensure the most effective procurement route.

There are no additional personnel requirements within this type of project, except for some additional time when setting up the new fuelling system.

The Financial Case

This section of the business case requires the local authority to set out the capital and revenue requirements for the spending proposal over the expected life span of the service. The costs will be dependent on the many factors covered previously and the parameters with potential costs are listed below.

Table 9. Biodiesel project costs

Cost	Cost range
New bunded fuel tank/dispenser	0-£10,000
Tank cleaning	£750 p.a.
Vehicle modification	0-£1,000
Vehicle sizing	£0-£8,000
Additional annual servicing	£200-£250 p.a.
Fuel cost	Variable
Increased fuel consumption	0-£200 per vehicle p.a.*
Fuel sampling	0-£240 p.a.

*Cost based on max 5% increase in fuel consumption.

The total cost for each project within a local authority can have a large variance and it is recommended that the above is tailored as per individual local authority need.

Within the business case, the overall effect on the total fleet division budget should be specified as this will show how little the move to biodiesel is likely to be, compared to the overall budget.

The Management Case

By ensuring a consistent fuel quality (using the EN 16709 standard) and by following vehicle manufacturers' maintenance requirements, such a B20 project is capable of being delivered successfully, in accordance with recognised best practice.

To ensure learning from the proposed project (and to follow Green Book best practice) future monitoring and post-implementation evaluation would be recommended for inclusion. Monitoring would take the form of MPG analysis for a period of 3 months prior to B20 use (in vehicles identified for B20 use). These figures would be compared to monthly periods once B20 use begins. Maintenance costs, driver feedback on vehicle performance and fuel pricing would also be monitored. An annual evaluation report would summarise the findings and may form part of a business case for further roll-out of B20 use, should the conclusions be as expected.

The best case scenario for local authority uptake of B20 provides a clear, low-cost method for achieving notable CO_2 reduction. Each local authority will have its own variables in terms of the availability of suitable vehicles and on-site fuel storage and where these variables are favourable, fleet managers are encouraged to consider biodiesel use. With the need for minimal investment, local authority carbon management plans should include B20 use as a priority measure amongst overall transport activities. Appendix A and B provide decision-making processes for consideration within B20 projects. In addition to these, the below decision factors should be reviewed.

Table 10. Biodiesel project decision factors

Cost	Decision factors
New bunkered fuel tank/dispenser	How many fuel tanks are there on-site? Are any of these fuel tanks suitable for conversion to B20 or B100? Is there space for storage of a new fuel tank? Will the fuel provider include the provision of a fuel tank in the contract? Can this provide at no cost for a trial?
Tank cleaning	Can this be included in the cost of the fuel provision? Can it be included as part of standard maintenance activities?
Vehicle modification	Can you consider a vehicle which does not require modification? If modifications are required can a bulk discount be applied?
Vehicle sizing	Does the manufacturer only warranty vehicles for B20 use which are larger than is required? Do other manufactures offer a similar product which can be warrantied for B20 use?
Additional annual servicing	Does your current servicing regime need additional checks, often stipulated by the manufacturer?
Fuel cost	Can the fuel provider provide guaranteed costs for the fuel over the life of the vehicle? Will the fuel provider commit to developing B20 production more locally?
Increased fuel consumption	Do you have the mechanism in place to review fuel consumption?
Fuel sampling	Can you ask the fuel provider to independently guarantee the quality of supply?

Further detail on issues such as the above are available within the Mayor's Biodiesel Programme Operational Note – available at www.london.gov.uk/biodiesel.

5 BIODIESEL OVERVIEW

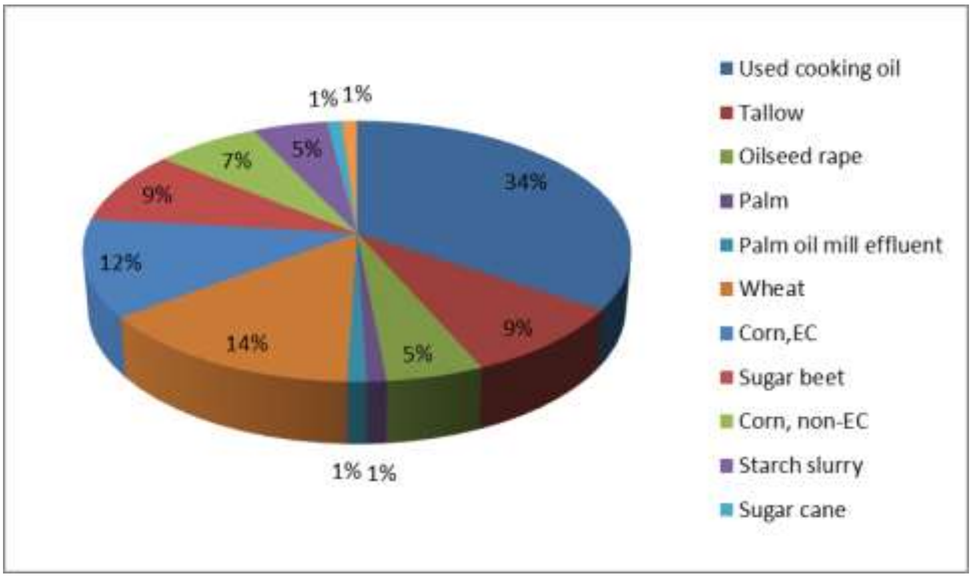
Having covered the cost and operational implications of B20 use, further background information shall be provided to provide a full picture of biodiesel adoption.

By 2020, the European Union aims to have 10% of renewable fuels in the transport fuel of every EU country. Within the UK, the EN590 standard allows for up to 7% biodiesel blend within standard diesel and the UK renewable fuels contribution is currently 2.85% of total road and non-road mobile machinery fuel[37]. It is clear therefore that significant progress is needed for the UK to achieve this binding target. This section will provide information on biodiesel and the available feedstocks, the air quality implications of biodiesel use and the future advancements expected within the industry.

5.1 Biodiesel trends

As can be seen in Figure 3.1 below, used cooking oil is currently the most used feedstock for UK biofuel, with a continuing trend away from crop-based biofuels due to historic concerns over sustainability and conflict with food crops (in 2009/10 crop-based biofuels made up more than 80% of the UK market). The benefits of biodiesel production from waste-based feedstocks are clear and as such the Renewable Transport Fuel Obligation (RTFO) rewards double certificates for their use, providing an incentive for the industry to deliver this lower CO_2 feedstock.

Figure 9. Biofuel Supply to the UK by Feedstock (2014/15)[38]



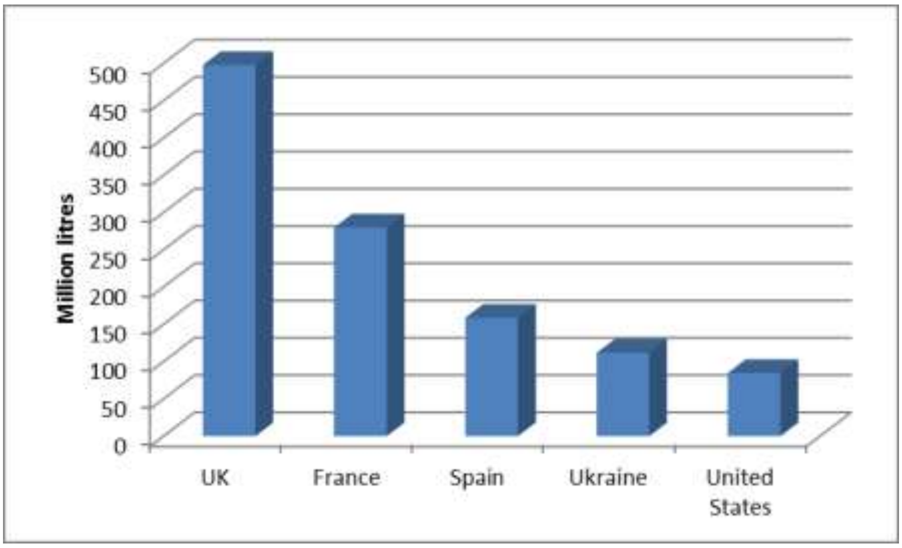
The aims of the Mayor's Biodiesel Programme revolve around the desire to use waste feedstock from London within the city itself, for all the reasons previously discussed. The benefits of local supply can also be seen in light of an analysis of the

[37] Renewable Transport Fuel Obligation statistics: obligation period 8, 2015/16, report 1, DfT
[38] Derived from RTFO Biofuel statistics: Year 7 (2014 to 2015), report 5, DfT.

current sources of biofuel used within the UK. Figure 3.2 below shows that less than 50% of biofuel used in the UK is sourced from within the country and there are clear CO_2 implications from the transport of such fuel from overseas.

For UK biodiesel deliveries there will still be CO_2 implications depending on the delivery model. Many of the major UK biodiesel suppliers are based in the north of England and Scotland and therefore transporting the fuel to London brings with it a greater CO_2 impact than if the fuel was sourced within London. To assess the lifecycle CO_2 implications of biodiesel sourced from London in comparison to elsewhere in the UK would be a complex task, laden with caveats. In addition to this, local authority CO_2 reporting would not consider the transport of the fuel prior to use. However, it is of use to consider the scenario of a 30,000 litre haulage tanker making a 600-mile round trip to London for biodiesel delivery purposes. Based on 7mpg and 2097g/mile CO_2, this would translate to an additional 43g CO_2 for each litre of fuel delivered[39]. Though the carbon footprint of such a delivery would be outwith the reporting parameters of a London borough, local delivery would ensure the wider benefits of an overall reduced footprint.

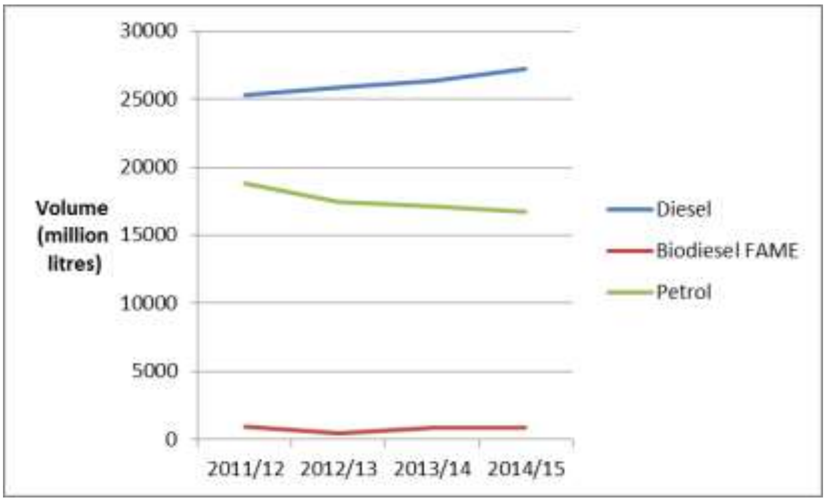
Figure 10. Top 5 countries supplying biofuel to the UK[40]



Biodiesel use in the UK will continue to be regulated and driven through the Renewable Transport Fuel Obligation, encouraging the production of biofuels that don't have a negative effect on the environment. The below graph shows UK fuel supply volumes since 2011/12 and it's evident that no significant increase in biodiesel use has been witnessed in the intervening years. It is such trends that have led to a continued push in advanced biofuels research, including 2nd and 3rd generation production (e.g. algae) with associated CO_2 savings and sustainability advantages.

[39] Though such a delivery would typically see a backload of UCO which would reduce the carbon impact per litre.
[40] Derived from DfT resource for Low Carbon Fuels Stakeholder Workshop, 12th November 2015

Figure 11. UK annual fuel supply volumes[41]



For biodiesel use to expand within London, it is not necessary for a wider UK increase in biodiesel adoption to be seen. With effective promotion and local, cost-neutral fuel supply of a consistent quality, then the local London market can be stimulated, independent of trends seen elsewhere in the UK. Within London, significant work has been undertaken to understand the potential market for utilising used cooking oil as a feedstock for transport fuel.

The 2013 LRS report[42] (produced for the Mayor's Biodiesel Programme) gave an estimate of 32-44 million litres of UCO waste arisings in the London area per annum. Whilst the suggestion is not that this is all readily available to fuel the fleets of London, it does clearly demonstrate the potential feedstock and the advantages of having a large production facility within London. Whilst it is clear that economic investment in a sizeable production facility would be greater than that in many other areas of the country where large plants have historically been situated (e.g. north of England and Scotland), what is offered in London is a large potential customer base and access to large feedstock supplies.

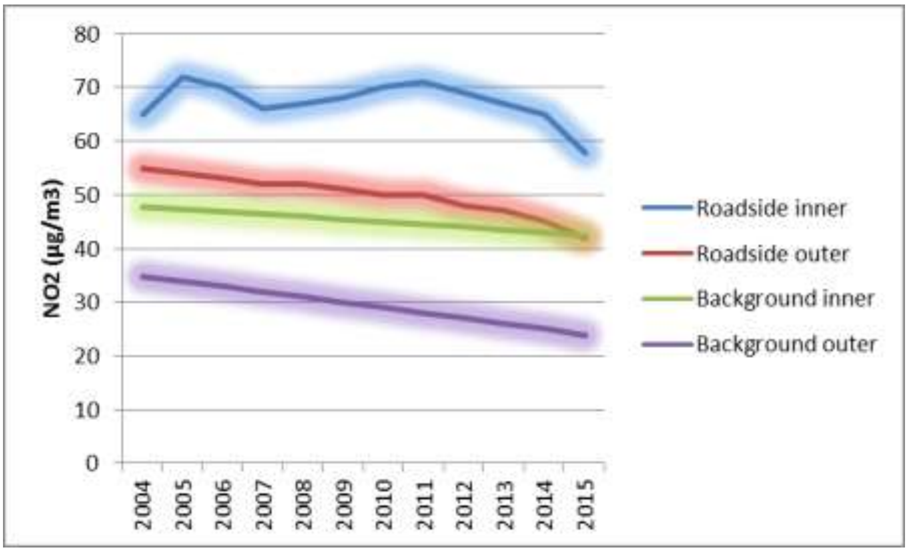
5.2 Air quality implications

Over recent years, air quality and pollutants from transport have become a primary focus of environmental policy within London. PM_{10} emissions in London generally do not exceed European limits. However, of growing concern are levels of $PM_{2.5}$ and the sources and impacts of this pollutant are currently being explored in more detail. Nitrogen Dioxide (NO_2) levels are however above European limits in London. Air pollution tends to affect the most vulnerable in society, with the elderly and those with existing medical conditions being most at risk. In addition, poor air quality can restrict lung development in children, with a recent study showing that outdoor air pollutants impair children's growing lungs and increase the risk of respiratory infections[43].

[41] Adapted from DfT RTFO Statistics
[42] The market for biodiesel production from used cooking oils and fats, oils and greases in London, LRS Consultancy, 2013.
[43] Urban Air Pollution and Respiratory Infections, Brugha R, Grigg J, 2014

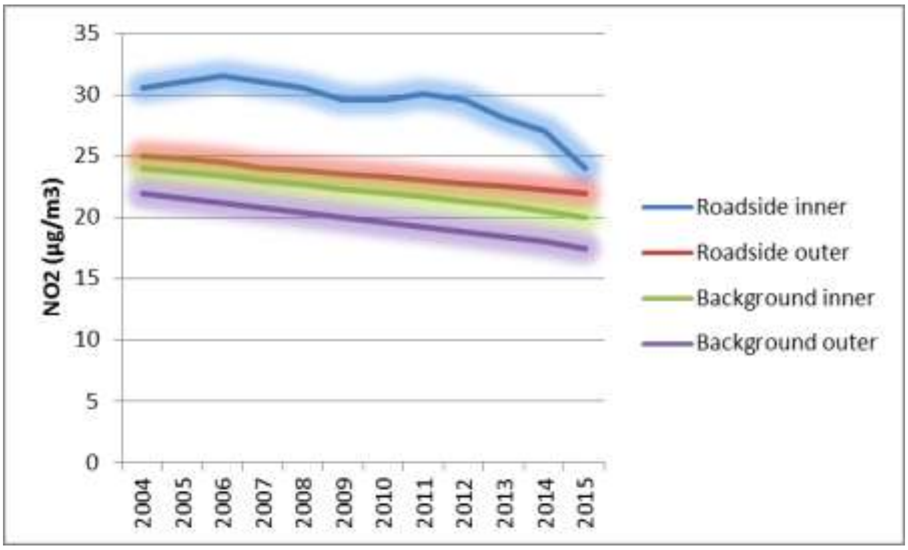
King's College recently quantified the health impacts of PM_{10}, $PM_{2.5}$ and NO_2 within London. The health burden of these pollutants was estimated at around 9,400 equivalent deaths brought forward in 2010[44].

Figure 12. Trends in NOx in London 2004-2014[45]



In addition to the direct negative health impact of Nitrogen Dioxide emissions, indirect effects are also found in their role in the creation of low-level ozone and the potential to add to acidification, with associated damage to forests and crops.

Figure 13. Trends in PM_{10} in London 2004-2014[46]



Motorised road traffic contributes 60 per cent of particulate matter in London and the vast majority of London now meets the European Union limit value for annual mean

[44] Travel in London, Report 8, Transport for London, 2015
[45] Derived from London Air Quality Network and analysis by King's College London
[46] Derived from London Air Quality Network and analysis by King's College London

atmospheric particulates[47]. It should be noted however that there is no "safe" level for PM_{10} so continued reductions are clearly necessary.

London's ambitious Ultra Low Emission Zone is set for introduction in 2020 and will go some way to accelerating the reduction of NO_x levels seen in the graph above. Biodiesel from waste-derived sources is a fuel that provides strong benefits in terms of low-cost CO_2 reduction (as discussed in Chapter 5) however its impact on air quality is less well understood.

There is not currently enough comprehensive evidence to promote the use of B20 or higher biodiesel blends as having air quality benefits. A number of the biodiesel producers engaged within this study (including Argent and Regenesis) promote their product as offering reductions in particulate matter and this meets with general academic consensus that most types of biodiesel from esterified vegetable oils can lead to reductions in HC, CO and PM emissions[48]. It should be noted however that there are many variables within the real-life assessment of vehicle pollutants, including vehicle age, maintenance condition, quality of the base fuel, type of engine and exhaust after-treatment technology.

Whilst particulate matter may be reduced, it is only with real-life testing (rather than a desk-based analysis) that this can be verified. Some vehicle testing (for a Euro V Alexander Dennis E400 bus) has been completed within the Mayor's Biodiesel Programme and this showed a slight PM_{10} reduction for B20 compared to standard diesel. There was no statistically significant difference in NO_x emissions between B20 use and standard diesel[49]. Further TfL testing in this field is planned and it is recommended that the results of this are disseminated through the Mayor's Biodiesel Programme[50].

Studies of a number of Euro standard engines have demonstrated an increase up to 10% NO_x emissions with 100% biodiesel use, in comparison to the use of standard diesel[51]. This should not be used as a guide for the use of B100 in more modern vehicles, which offer further advanced after-treatment systems. However, with the increasing emphasis within London on the need to improve air quality, the implications of B100 on NO_x emissions need further investigation.

Whilst B20 should not be promoted as a route to air quality improvements, its use is unlikely to lead to poorer air quality. More testing is required to better understand the air quality implications of B100.

[47] Transport for London, Roads Task Force - Technical Note 21
[48] Road Transport Biofuels: Impact on Air Quality, Air Quality Expert Group, 2011
[49] Biodiesel Operational Note, Greater London Authority, June 2015
[50] Biodiesel Operational Note, Greater London Authority, June 2015
[51] Emissions Factors For Alternative Vehicle Technologies, Murrells, T. and Pang, W. 2013 and Review of the Effects of Biodiesel on NOx Emissions, Hoekman, K and Robbins, C. 2012

6 CONCLUSION

The findings within this report show that the transitioning to a 20% blend of biodiesel should be considered a business as usual activity for many local authorities in London. Doing this would deliver cost competitive CO_2 reductions with little change in existing practice.

There are a variety of alternative fuels available to fleet operators and many other energy efficiency projects which could be explored by local authorities. B20 uptake is shown to compare favourably with many of these options, making it a useful transitional fuel on the journey to low and zero emission transport solutions. B20 should be considered within local authority fleets and proposed to senior management to aid delivery of local authority carbon management plans.

B20 has the ability to deliver up to 15% CO_2 savings within fleet operations, with minimal capital and revenue expenditure. It can deliver CO_2 savings for a cost effectiveness of £43/t CO_2 and whilst it does not deliver on-going fuel cost savings, it is a proven and credible option to deliver environmental benefits. New European Standards for B20 and B30 have been recently approved in the UK (EN 16709) which will allay any historic concerns over fuel quality. Procuring B20 to this standard should be seen as essential and will be feasible through a number of suppliers in the current market.

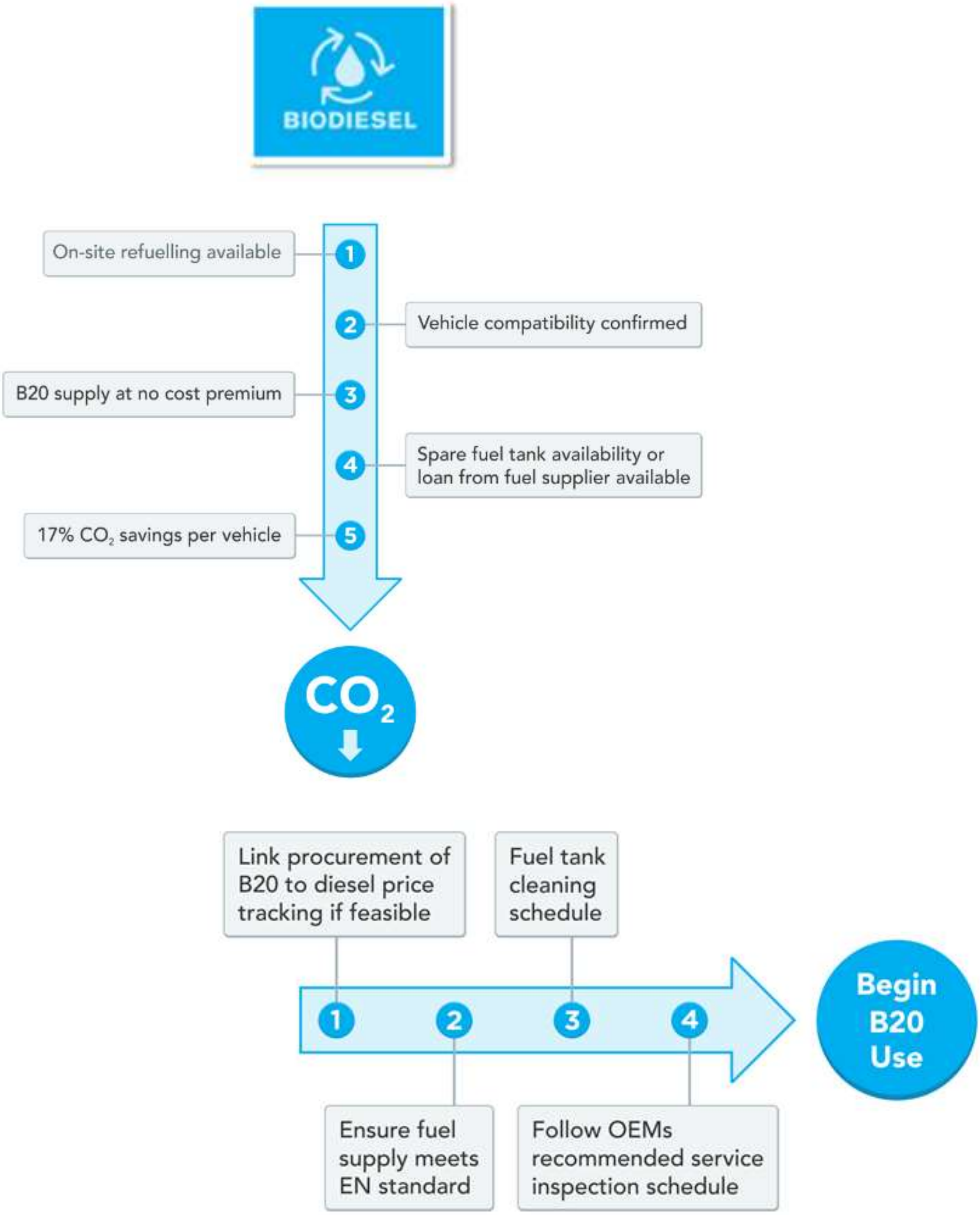
An increasing number of vehicle and engine manufacturers now provide warranties for B20 use and will also provide recommendations for B20 use in out-of-warranty vehicles due to these new fuel standards. With good management, B20 can be introduced within such vehicles, taking care to follow manufacturers' advice relating to a more frequent service inspection regime.

It is recommended that all local authority heavy-duty trucks are assessed for switching to B20 adoption, where on-site depot re-fuelling is available. Biodiesel is particularly complementary within heavy-duty trucks due to the larger engines, however procurement options should also be explored within light commercial vehicles. There are current manufacturers providing warranties for use with biodiesel blends of up to B30 in vans. In addition it is recommended that any outsourced fleet operations include biodiesel options in future procurement rounds.

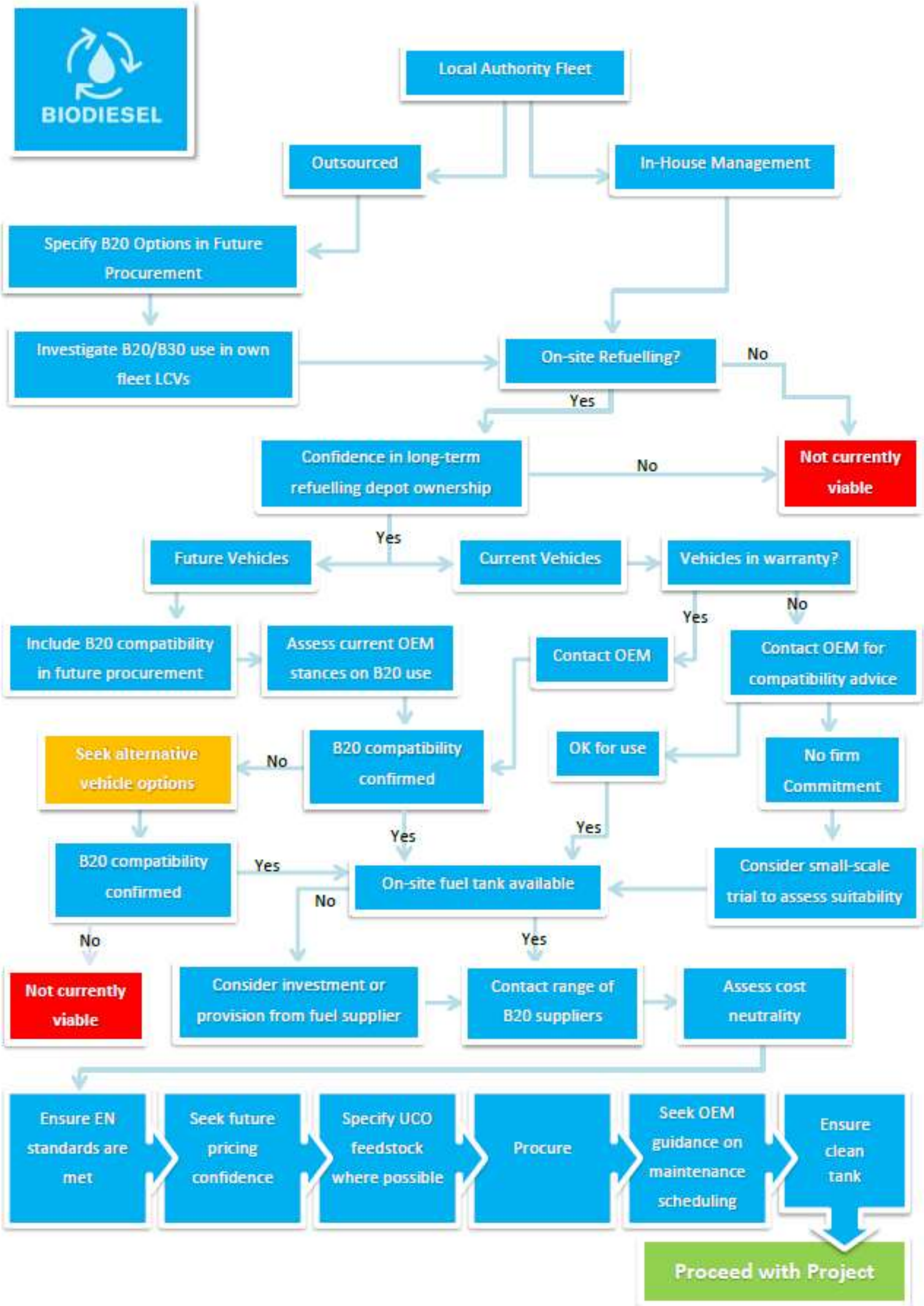
There are a number of large waste contractors and logistics operators now using or trialling biodiesel and further confidence in the fuel should be gained from the large-scale adoption with the London bus fleet. 3,000 buses will be using B20 by the end of 2016, with that set to increase to the whole London bus fleet by 2020. Undertaken for CO_2 reduction purposes, it is further evidence of B20 adoption becoming a business as usual activity.

In terms of both the ease and cost of implementation, B20 offers greater opportunity than the alternative fuels and many energy efficiency measures considered within this report. With the lowest level of investment needed in terms of both vehicles and infrastructure cost for any alternative fuel, B20 uptake should be prioritised within fleet strategies for the low cost CO_2 reduction that it offers. Its use should also be promoted at a wider management level, with inclusion in council carbon management plans to ensure full awareness of this achievable route to CO_2 savings.

7 APPENDIX A – PROJECT PROCESS OVERVIEW



8 APPENDIX B – LOCAL AUTHORITY DECISION-MAKING TREE



9 APPENDIX C – BUSINESS CASE TEMPLATE

The Strategic Case

Fundamental to the strategic case for B20 use is the low-cost CO_2 reduction that its use offers. CO_2 reduction requirements are driven at EU, UK and regional level by the following:-

- EU Renewable Energy Objective - 10% of final energy consumption in the transport sector must come from renewables by 2020. Each Member State has an individual target within RED and the UK's target is for 15%[52].
- UK Climate Change Act 2008 – Target to reduce UK's greenhouse gas emissions by at least 80% (from the 1990 baseline) by 2050. 2020 target of 20% reduction compared to the 1990 baseline.
- Contribution to the strategy laid out in London's Transport Emissions Roadmap, which specifies a 2025 scenario for heavy duty vehicles, where 12% of fleet would operate on higher blend (B20) sustainable biodiesel
- Each individual council has a Carbon Management Plan which sets out CO_2 reduction targets.

Maintaining the status quo in terms of local authority fleet operations will fail to produce the necessary CO_2 reductions. Much of the "low hanging fruit" in terms of fleet CO_2 savings (e.g. telematics, good fuel management, driver training etc.) have already been implemented and to achieve further savings, alternative fuels need to be adopted. Of these alternative fuels, biodiesel use is the most cost-effective in terms of investment.

Iin best-case scenarios B20 can be adopted for a notional additional cost of around £200 per vehicle p.a. (the cost of an additional annual service/filters/oil change) and an annual £750 tank cleaning cost.

The Economic Case

B20 use has strong potential as a cost effective CO_2 reduction measure, should the appropriate conditions exist. With a best-case cost effectiveness of £43/t CO_2, B20 compares favourably with many common energy efficiency measure frequently employed by local authorities within London. Whilst no fuel savings are gained through B20 use (and hence no overall return on investment) the available CO_2 savings come at little cost.

The Commercial Case

Planning and management of the procurement needs within a B20 project will be catered for within current processes. Both fuel suppliers and vehicle suppliers are

[52] Climate Change Legislation in the EU, Committee on Climate Change - https://www.theccc.org.uk/tackling-climate-change/the-legal-landscape/european-union-legislation/

currently procured through a competitive tender process, with only minor specification changes needed to include B20 use. It is recommended that fuel pricing within biodiesel procurement is linked to crude oil pricing where possible and that vehicle procurement does not favour larger engine vehicles (which may be more likely to be warrantied for B20 use but may come with a cost premium and increased fuel consumption). It is advised that the recommendations within London Councils' Best Practice Guide on Vehicle Acquisition are followed to ensure the most effective procurement route.

There are no additional personnel requirements within this type of project.

The Financial Case

This section of the business case sets out the capital and revenue requirements for the spending proposal over the expected life span of the service. The costs can be dependent on many factors and the parameters with potential costs are listed below:-

Cost	Factors	Cost range
New bunded fuel tank/dispenser	Dependant on capacity. Can also be hired or potentially provided gratis by fuel supplier.	0-£10,000
Tank cleaning	Best practice for an annual clean compared to every 2-3 years for standard diesel tanks	£750 p.a.
Vehicle modification	Some new vehicles come with small premium for biodiesel modifications	0-£1,000
Vehicle sizing	Some manufacturers only warrant B20 use for vehicles above the normal engine size needed by council fleets	£0-£8,000
Additional annual servicing	Noted as best practice	£200-£250 p.a.
Fuel cost	Can potentially be sourced with no cost premium	Variable
Increased fuel consumption	Not proven as an issue and unlikely to lead to additional costs	0-£200 per vehicle p.a.*
Fuel sampling	Unlikely to be necessary unless there are quality issues	0-£240 p.a.

*Cost based on max 5% increase in fuel consumption.

The total cost for each project within a local authority can have a large variance and it is recommended that the above is tailored as per individual local authority need.

Within the business case, the overall effect on the total fleet division budget should be specified.

The Management Case

By ensuring a consistent fuel quality (using the EN 16709 standard) and by following vehicle manufacturers' maintenance requirements, such a biodiesel project is capable of being delivered successfully, in accordance with recognised best practice.

To ensure learning from the proposed project (and to follow Green Book best practice) future monitoring and post-implementation evaluation would be recommended for inclusion. Monitoring would take the form of MPG analysis for a period of 3 months prior to biodiesel use (in vehicles identified for B20 use). These figures would be compared to monthly periods once biodiesel use begins. Maintenance costs, driver feedback on vehicle performance and fuel pricing would also be monitored. An annual evaluation report would summarise the findings and act as an argument for further roll-out of B20 use, should the conclusions be as expected.

The best case scenario for local authority uptake of B20 provides a clear, low-cost method for achieving notable carbon reduction. With the need for minimal investment, local authority carbon management plans should include B20 use as a priority measure amongst overall transport activities.

10 APPENDIX D - FUEL SUPPLIER/PROCUREMENT INFO

There are a number of biodiesel suppliers operating within the UK that can provide B20 and higher blends to customers within London. The list below details those that have been engaged within the Mayor's Biodiesel Programme and beyond.

Supplier	Further information	Phone
Argent Energy	www.argentenergy.com	01698 863000
City Oils	www.cityoils.co.uk	0208 555 4911
Convert2Green	www.convert2green.co.uk	01606 833330
Green Biofuels	www.greenfuels.co.uk	0208 133 3869
Greenergy	www.greenergy.com	020 7404 7700
Hall Fuels	www.hallfuels.co.uk	01784 411500
Harvest Energy	www.harvestenergy.co.uk	020 7580 0033
Olleco	www.olleco.co.uk	01236 433567
Proper oils	www.properoils.co.uk	0845 470 8091
Regenesis Bioenergy	www.regenesisbioenergy.com	01952 605036
RGM Fuels	www.rgmfuels.co.uk	01234 756026
Uptown Oil	www.uptownoil.co.uk	0-20 7928 6300

The above list should not be viewed as exhaustive and the inclusion of a supplier's details should not be viewed as a recommendation or as certification of the suitability of their fuel.

It is recommended that engagement with suppliers includes the following conditions for biodiesel procurement:-

- Biodiesel price is linked to variances in the price of standard diesel, to ensure that a cost premium is avoided where possible.
- All biodiesel products are certified to the recognised EN 14214 standard for FAME.
- All B20/B30 fuel meets the recently approved EN 16709:2015 standard.
- Fuel sampling to be included should there be any valid concerns over quality.
- Used cooking oil from within London being the preferable feedstock.
- Proven supply chain management processes.

For wider information on the procurement of clean and efficient vehicles, the EU Clean Fleets project has been designed to assist local authorities and public fleet operators in purchasing clean and energy efficient vehicles in full compliance with European legislation – in particular the Clean Vehicles Directive, Full information, including a life-cycle cost tool can be found at www.clean-fleets.eu.

11 APPENDIX E – TEMPLATE LETTER TO VEHICLE MANUFACTURER

After engagement with the Mayor's Biodiesel Programme in London, as a local authority we would like to assess the feasibility of trialling B20 fuel within our fleet. As you may be aware the programme aims to stimulate biodiesel uptake in London, primarily using local Used Cooking Oil (UCO) and Fats, Oils and Greases (FOG) as the preferred feedstock within the production of the fuel.

We currently operate your vehicles/We are considering procuring your vehicles (DELETE AS APPROPRIATE) and we would like to receive advice on the use of B20 which would comply with the EN 16709 standard within the following vehicles:-

Model	Weight	Hp	Euro Standard

I would request that you provide information as to the above vehicles' compatibility with B20 and any additional information on recommended amendments to maintenance schedules, warranty issues, oil drain intervals etc.

Any information on future vehicles and their suitability for biodiesel or HVO use would also be much appreciated.

For wider information, the aims of the Mayor's Biodiesel Programme (as managed by Greater London Authority) are as follows:-

- Enhance the circular economy, with local waste products utilised within the region – leading to the creation of employment opportunities.
- Reduce the CO_2 impact of local authority fleets.
- Alleviate stresses on the sewer system, with reductions in the cost of blockage mitigation.

Co-signed by Greater London Authority (GLA logo to be attached)

12 APPENDIX F – RISK REGISTER TEMPLATE

No.	Risk	Mitigating action	Owner	Probability	Severity	RAG rating
B20.1	Future restrictions with on-site refuelling	Seek management confirmation of future of on-site assets.				
B20.2	Price volatility of B20	Build price constraints into fuel procurement.				
B20.3	Guaranteed fuel supply	Seek evidenced supplier assurances.				
B20.4	Inconsistent fuel quality	Ensure fuel is procured to EU standards, with fuel sampling if issues occur.				
B20.5	Voiding of vehicle warranties	Ensure OEM approval is sought for any vehicles under warranty.				
B20.6	Technical vehicle issues	Follow recommended maintenance schedules on filter and oil drain intervals. Annual fuel tank cleansing. Ensure fuel is procured to EU standards, with supplier-led fuel sampling if issues occur.				
B20.7	Increase in fuel consumption	Small-scale trial with MPG monitoring and a supplier onus to address any issues.				
B20.8	Fuel degradation	Annual fuel tank cleansing. Use appropriate pump filters. Addition of anti-microbial products if recommended by fuel supplier.				
B20.9	Concerns over fuel sustainability	Seek evidenced supplier assurances.				
B20.10	Concerns over air quality implications	Seek evidenced supplier assurances. Undertake Portable Emissions Monitoring.				
B20.11	Cold-weather impact on fuel (e.g. waxing)	Seek supplier assurances. Ensure EU fuel standards within procurement. Use of cold-flow additives in extreme conditions. Fuel heater at temperatures below -15 degree Celsius.				

NB. Provided as a template to aid with project proposals, with shaded columns for local authority completion

Other formats and languages

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

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Chinese

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Hindi

यदि आप इस दस्तावेज की प्रति अपनी
भाषा में चाहते हैं, तो कृपया निम्नलिखित
नंबर पर फोन करें अथवा नीचे दिये गये
पते पर संपर्क करें

Vietnamese

Nếu bạn muốn có văn bản tài liệu
này bằng ngôn ngữ của mình, hãy
liên hệ theo số điện thoại hoặc địa
chỉ dưới đây.

Bengali

আপনি যদি আপনার ভাষায় এই দলিলের প্রতিলিপি
(কপি) চান, তা হলে নীচের ফোন্ নম্বরে
বা ঠিকানায় অনুগ্রহ করে যোগাযোগ করুন।

Greek

Αν θέλετε να αποκτήσετε αντίγραφο του παρόντος
εγγράφου στη δική σας γλώσσα, παρακαλείστε να
επικοινωνήσετε τηλεφωνικά στον αριθμό αυτό ή ταχυ-
δρομικά στην παρακάτω διεύθυνση.

Urdu

اگر آپ اِس دستاویز کی نقل اپنی زبان میں
چاھتے ھیں، تو براہ کرم نیچے دئے گئے نمبر
پر فون کریں یا دیئے گئے پتے پر رابطہ کریں

Turkish

Bu belgenin kendi dilinizde
hazırlanmış bir nüshasını
edinmek için, lütfen aşağıdaki
telefon numarasını arayınız
veya adrese başvurunuz.

Arabic

إذا أردت نسخة من هذه الوثيقة بلغتك، يرجى
الاتصال برقم الهاتف أو مراسلة العنوان
أدناه

Punjabi

ਜੇ ਤੁਹਾਨੂੰ ਇਸ ਦਸਤਾਵੇਜ਼ ਦੀ ਕਾਪੀ ਤੁਹਾਡੀ ਆਪਣੀ ਭਾਸ਼ਾ
ਵਿਚ ਚਾਹੀਦੀ ਹੈ, ਤਾਂ ਹੇਠ ਲਿਖੇ ਨੰਬਰ 'ਤੇ ਫ਼ੋਨ ਕਰੋ ਜਾਂ ਹੇਠ
ਲਿਖੇ ਪਤੇ 'ਤੇ ਰਾਬਤਾ ਕਰੋ:

Gujarati

જો તમને આ દસ્તાવેજની નકલ તમારી ભાષામાં
જોઇતી હોય તો, કૃપા કરી આપેલ નંબર ઉપર
ફોન કરો અથવા નીચેના સરનામે સંપર્ક સાધો.

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