Final Report

Low Carbon Bus Procurement – Feasibility Study

Prepared for Low Carbon Vehicle Partnership

By

Sustainable Transport Solutions

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Draft report

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By **Sustainable Transport Solutions Network**

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Executive Summary

The Low Carbon Vehicle Partnership commissioned Sustainable Transport Solutions Ltd to conduct a feasibility study of how a Forward Commitment strategy for procuring innovation might be applied to transforming the market for low carbon buses in the UK. In doing this the study addresses the following key issues;

- Whether there is sufficient interest amongst local transport authorities, bus operators and manufacturers in low carbon bus procurement.
- Whether the current and potentially forthcoming policy drivers available to create or support a market for low carbon buses are sufficient, in particularly outside London.
- What contractual structures would be required to deliver a Low Carbon Bus Forward Commitment.
- What size of order is required to establish economies of scale.
- Whether low carbon buses are viable and identify potential sources of financing the forward commitment.
- Develop a draft low carbon bus specification as a basis for future discussion with stakeholders.

The feasibility study was undertaken between October 2007 and March 2008 through a survey of the current and proposed legislation and regulation for the bus market in the UK, a series of interviews with key stakeholders and a focused workshop based upon the provisional conclusions. A summary of the conclusions follows.

Stakeholder Interest

The study concludes that there is significant support from stakeholders in the UK bus market to form the basis for a Forward Commitment for low carbon buses. On the supply side there is interest from all the major bus manufacturers and system suppliers active in the UK, many of which are involved in trials of hybrid buses in London with TFL.

On the demand side there is significant interest from PTAs to improve the environmental impact of buses and a willingness to develop the notion of a joint procurement of low carbon buses further. Indeed, PTEG has commissioned a study on behalf of its members into bus technology and carbon foot printing of buses. While there was also interest amongst bus operators, their overriding concern was in the commercial viability of low carbon buses and the reliability of

new technologies. These concerns would need to be addressed if a sustainable market is to be established.

Policy Drivers

The current regulatory framework in London and the rest of the UK is fundamentally different. In London, Transport for London (TfL) has the ability to create a market demand for low carbon buses, and the Mayor and the Greater London Authority (GLA) have created the policy framework to make reducing carbon emissions a priority. Outside London local transport authorities are currently constrained by legislation and there are few direct opportunities for them to specify low carbon buses in their areas.

However, the Local Transport Bill when enacted will provide new enabling powers for local transport authorities, including Passenger Transport Authorities (PTA), which should give more flexibility for introducing low carbon buses, in particular on subsidised routes, contracted routes, in-house services and through Quality Partnerships and Contracts. In addition the revival of powers for PTAs to purchase buses and lease them to operators would give PTAs an important role in determining which vehicles are procured for these services.

The Department for Transport (DfT) is currently consulting on possible changes to the Bus Services Operators' Grant (BSOG). Options for reform include improved incentives for operators to invest in new technology, particularly low carbon buses, which if adopted would remove a major barrier to the introduction of low carbon bus in the UK. We understand this could happen as early as the autumn of 2008.

Contractual Considerations

A Forward Commitment is not usual practice in the bus industry and as such their maybe institutional barriers to its implementation. However it appears to be an achievable approach to procurement.

Underlying a Forward Commitment would be contracts creating the demand for the low carbon buses local transport authorities and bus operators. This would be achieved through a range of contracts and agreements including; local authority controlled routes, quality partnerships and Statutory Quality Partnerships (SQP).

A Forward Commitment once entered into would set out a series of contracts, each invoked by the successful performance of the previous contract covering trial of new technologies, small fleet demonstration and final procurement of market ready low carbon buses in volume. The final element would be a call off contract for the supply of vehicles which would provide a framework for supply contracts between the bus operator and the supplier.

From a contractual point of view the existing contractual practices would remain the same although they would have to be amended in a number of ways in order

to deliver a low carbon bus forward commitment, not least to reflect KPIs appropriate for the demonstration and trial of low carbon buses.

In the short term local authority controlled bus services can and will provide the best application in which to demonstrate and trial low carbon buses, as part of a low carbon bus forward commitment. However in order to deliver a sustainable market for low carbon buses will require the development of SQP.

Commercial Viability
Cost-effectiveness is a major issue for low carbon buses under the current regulatory and fiscal regime. However, the proposed powers set out of the Local Transport Bill and the proposed amendments to the bus subsidy set out in the bus subsidy consultation offer the potential for low carbon buses, delivering in excess of a 40% reduction in carbon dioxide emissions, to be commercially viable in the UK.

Without these new powers or the reform of the bus subsidy there are a range of near market technologies capable of combination to deliver between a 20% to 40% reduction in carbon emissions. The viability of these technologies is largely independent of the regulatory and fiscal regime and could be viable in the commercial bus markets.

Specification of Low Carbon Bus
It is clear that the regulatory and fiscal regime under which buses operate in the UK may change significantly during the next year. In order to cope with this uncertainty and deliver a usable draft low carbon bus specification for use in future discussions with stakeholders, a two tier specification has been developed. This has as a target for GHG reduction of 20% and 40% respectively when measured over the MLTB bus drive cycle.

While the targets for the Forward Commitment process should be framed against clearly defined basis, the final target which triggers the purchase commitment will be based upon in-service performance.

It will be dependent on the future structure of BSOG whether Tier 1 or Tier 2 should be used for a forward commitment process; there may even be scope for them to run in parallel.

Based upon feedback from bus manufacturers, it is believed that in order to achieve significant cost reductions component production would need to be of the order of 1000 systems p.a. There were only 2,300 new buses registered in the UK during 2007 of which London accounts for approximately 500 buses. Consequently there is considerable benefit in seeking to collaborate with European partners to increase potential market volumes.

Recommendations

It is recommended that a strategy for the LowCVP in taking forward a low carbon bus initiative should comprise the following elements:

1. Undertake a telephone survey of PTAs and a representative sample of local transport authorities and bus operators in order to establish more clearly the extent of market demand for low carbon buses;

2. Liaison with TfL to gain from their experiences of specifying and procuring hybrid vehicles in London;

3. Discussions with the PTAs and PTEG, and leading local transport authorities, in order to develop the ideas from this feasibility study further, including the possibility of a non-London based approach to specifying and procuring low carbon buses;

4. Continue to press for reform of BSOG and in particular for a flat rate alternative to BSOG for low carbon buses in the short term;

5. The Include bus driver training, via an activity such as SAFED, in the development of a fleet procurement programme;

6. Seek to secure low carbon buses as part of the Low Carbon Vehicle Procurement Programme;

7. The development of a Strategic Quality Partnership framework that could be applied around the UK which incorporates encouragement for low carbon buses;

8. Develop a set of KPIs and standards around the environmental performance of low carbon buses for each stage in the Forward Commitment process;

9. Develop a minimum level of KPIs applicable to the support, maintenance and aftermarket support of buses and their technologies designed to provide a framework for manufacturers and operators

10. Develop a strategic partnership with PTEG and CPT to promote understanding of the procurement processes required to implement a Forward Commitment.

1. Introduction

This document forms the first draft of the final report of the Low Carbon Bus Procurement Feasibility Study. The document reports the findings of the research into the policy drivers, contractual issues and a draft specification for a low carbon bus and provides recommendations on the application of the Forward Commitment approach to bus market in the UK, and in particular outside London.

1.1. Project Objectives

The Low Carbon Vehicle Partnership in October 2006 presented Government with the Partnership's recommendations on how to revise the Powering Future Vehicle Strategy. One of the recommendations was that greater use should be made of Forward Commitments to procure low carbon vehicles in particular with regard to low carbon buses.

The purpose of the project is to conduct a feasibility study of how a Forward Commitment project would work when applied to the low carbon buses and the UK bus market. The study also outlines how a Forward Commitment would be implemented in the UK bus market, and specifically outside London.

The objective of the project is to determine whether a forward commitment strategy is feasible in the UK bus market for low carbon buses.

- Establish stakeholder interest in low carbon bus procurement and whether there is an unmet need which has the potential to be realised. It is assumed that the demand would come from public bodies rather than bus operators.

- Identify the existing and potentially forth coming policy drivers available to create or support a market for low carbon buses, in particularly outside of London.

- Establish the contractual structure which would be required to deliver a Low Carbon Bus Forward Commitment.

- Low carbon bus specification. Develop a draft specification of a low carbon bus appropriate for procurement processes. This specification would be shared with TfL and the TRUS consortium which is looking at the potential for common European specification

- Supplier feedback would be sought on the draft specification and the volumes required to establish economies of scale.

- To identify potential sources of financing the forward commitment. This could be through Central Government funding, local authority controlled funds, other sources.

1.2. Project deliverables

There are four main project deliverables which were as follows:

D1. Presentation of primary research
A presentation in Powerpoint covering the results of the primary research conducted was presented to the Bus Working Group on the 15th November 2007. Comments from the Bus Working Group were incorporated into the project and helped guide further research and the development of conclusions.

D2. Integration of the results and preliminary conclusions
A workshop was held on the 18th January to present the preliminary conclusions drawn from the research to members of the Low Carbon Vehicle Partnership and a selected group of bus industry stakeholders including Passenger Transport Executives, local authorities, bus operators and bus manufacturers and system suppliers.

D3. Draft report
A written draft of the complete report will be presented for comment and approval to either the Bus Working Group or the Sub-Group in January 2008. Comments collected during the meeting and written comments provided following the meeting will be incorporated into the final report. The written report will be provided 7 working days prior to the meeting.

D4. Final report
A final report will be delivered to the LowCVP Secretariat by the 30th March 2008.

1.3. Structure of the report

The report is divided into 8 sections. Section 1 is a general introduction. Section 2 looks at the background to the study and the bus market in the UK as a whole. A definition of a low carbon bus is set out, as previously defined by the Low Carbon Vehicle Partnership, the innovation process required to bring low carbon buses to market is considered and the role of joint procurement as a means of managing the supply chain and a means of reducing risk.

Section 3 sets out the methodology followed in the project. It details the approach taken to researching the project, how this was structured, whether information was sourced from and the level of stakeholder input and review.

Section 4 reviews the level of stakeholder interest in low carbon bus procurement. The key focus is on interest from public sector bodies and in particular PTAs and local transport authorities which are assumed to provide the most likely source of demand. The key issue addressed is whether there is an

unmet need which has the potential to be realised through the provision of low carbon buses

Section 5 addresses the existing and potentially forthcoming policy drivers available to create or support a market for low carbon buses. Given the strategy being followed by TfL in demonstrating hybrid buses and improving the environmental performance of the fleet of London buses, the focus is placed on the policy drivers for developing the market outside London.

Section 6 looks at the procurement processes in place, the issues which would need to be addressed in using joint procurement for low carbon buses and the contractual structures required to deliver a Low Carbon Bus Forward Commitment.

Section 7 reviews the viability of low carbon buses and the potential funding streams required for the Forward Commitment are considered.

Section 8 presents a low carbon bus specification. This specification was developed in consultation with all bus industry stakeholders and is intended to be appropriate for use as a starting point for a low carbon bus procurement process. It is intended that this specification would be shared widely and will help prevent a proliferation of low carbon bus specifications.

Supplier feedback would be sought on the draft specification and the volumes required to establish economies of scale.

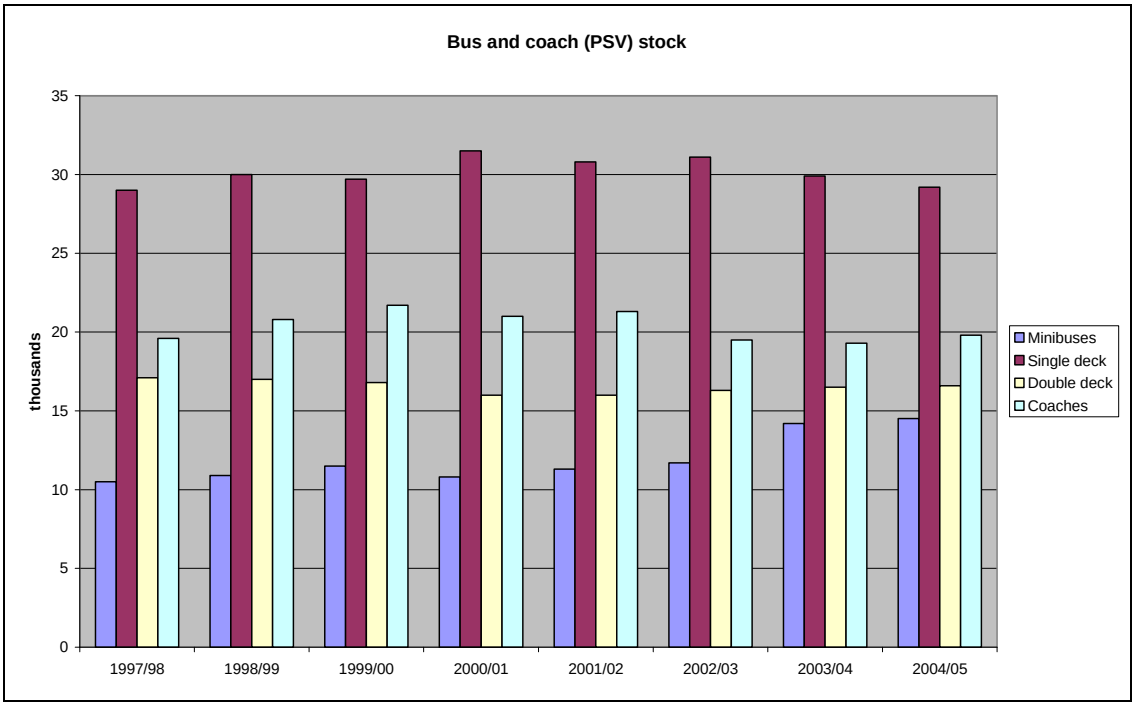
2. Background

The development of a market for low carbon buses has been frustrated in the UK by market failure to value low carbon, and market barriers in the form of the regulatory regime outside London and the form of bus subsidy made through the Bus Service Operators Grant (BSOG). It now appears that the Government is seriously considering amending the regulatory framework and the form of support provided to the bus industry to ensure value for money in terms of increasing patronage and reducing pollution from buses.

Government's thoughts were set out in the document "Putting Passengers First" which stimulated debate with industry and led to the draft Local Transport Bill currently passing through Parliament and a formal consultation on the bus subsidy which was announced with the Budget on the 13th March 2008.

2.1. UK Bus Market

There are currently 103,000 buses and coaches registered in the UK, of which 80,000 are Public Service Vehicles (PSV). The target for low carbon buses was framed originally as buses over 8.5 tonnes incorporating full sized single and double deck buses of which there are circa. 46,000 in operation in the UK (see graph below).

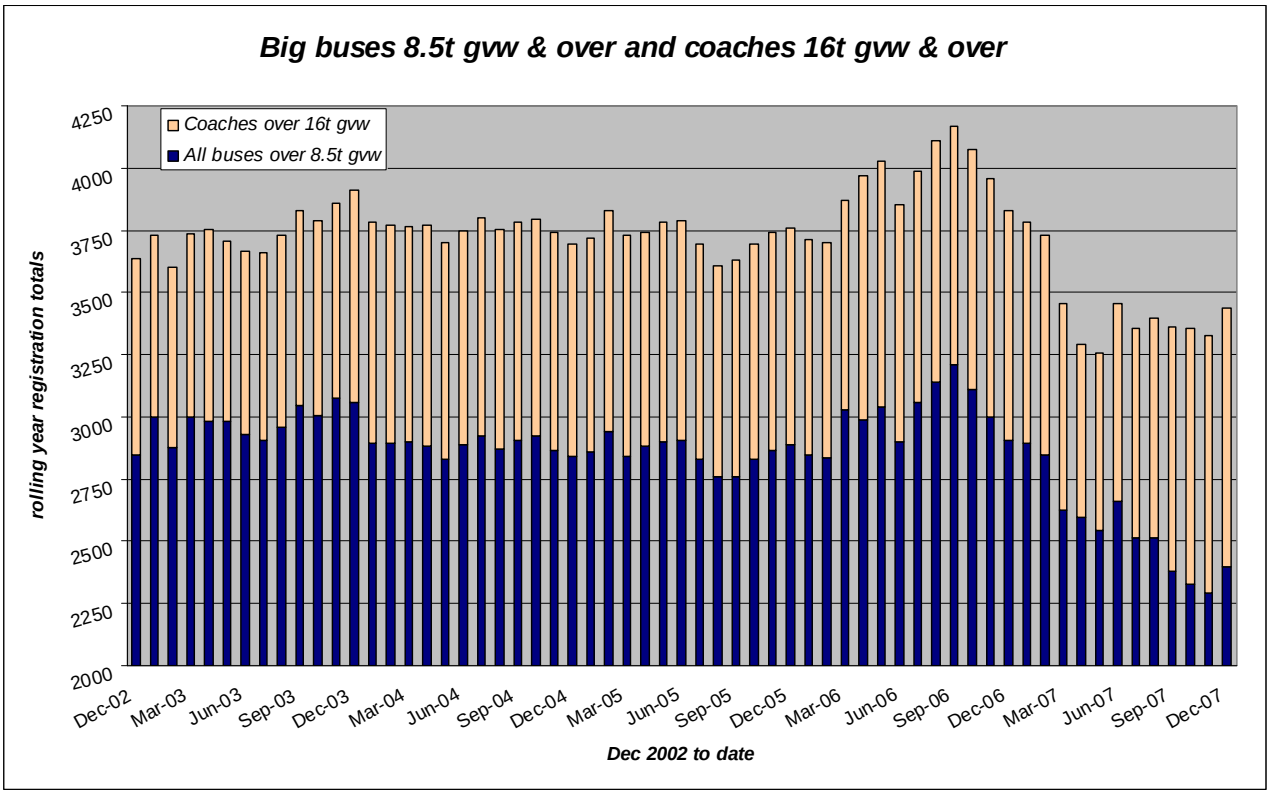


Source: SMMT

Total bus and coach registrations in the UK have varied between 3,250 and 4,250 vehicles on a rolling twelve month basis, of which buses over 8.5 tonnes

account for approximately 75%, or approximately 3,000 vehicles per annum. However, in the last twelve months new registrations of buses has fallen to total 2,397 vehicles in 2007. London accounts for between 500 to 600 buses per annum (approximately 20%).

In terms of sales the UK bus market is dominated by 5 manufacturers. In 2007 Volvo had the largest market share with 22.5%, followed by Alexander Dennis with 17.6%, with Optare, Irisbus and Scania with 11.7%, 11.3% and 10.4% respectively.



Source: SMMT

Prior to 1986 bus services were provided by local authority owned operators, subsidiaries of publicly owned corporations and smaller private companies. The Transport Act 1985 was introduced to promote competition and efficiency, limit use of public monies in funding bus operations; it also removed the requirement for road service licensing outside London.

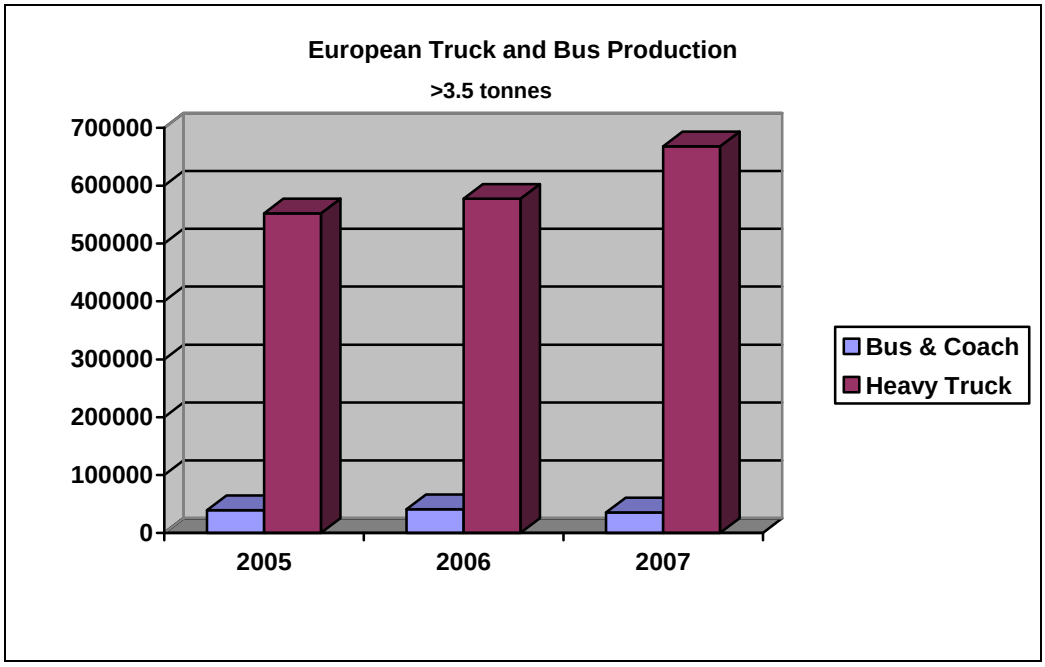
The regime operates differently in London from the rest of the UK. In London a system of competitive tendering for bus routes operates, tendered by TfL as the executive agency of the GLA. In the rest of the UK bus operators are required to register services with the Traffic Commissioner giving 56 days notice of intention to set up or cease to operate a service and provide information on the proposed route. In the major conurbations public transport is then co-ordinated by the

Passenger Transport Executives (PTE) who are responsible to the local authorities in their area, via the Passenger Transport Authority, and act in partnership with private operators to provide public transport.

2.2. Buses Production

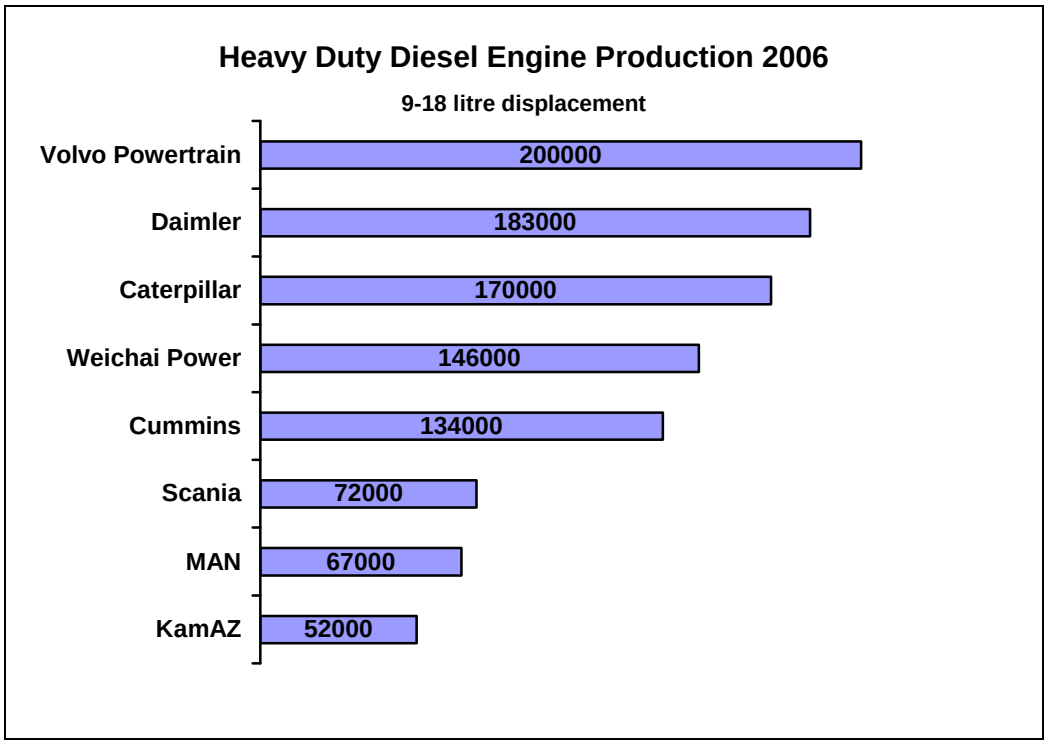
Bus production volumes are significantly lower than that for truck production, and consequently economies of scale and research and development is highly dependent on the truck market. European bus and coach production in 2007 was over 35,691 compared to heavy commercial vehicle production which was 667,864.

There are 13 countries in Europe which manufacturer buses, however bus manufacture in Europe is focused in three countries in particular Germany, home of Mercedes Benz, Sweden, which manufacturers Volvo and Scania buses and France, where Renault manufactures. The UK produced 1,355 buses in 2007 greater than 3.5 tonnes and accounts for 4% of European manufacturer.



Source: ACEA

The development of engines and other driveline components are driven by the truck market. However strategies to improve fuel efficiency and reduce carbon dioxide emissions will be increasingly duty cycle driven. Bus duty cycles do share characteristics with those for refuse collection and urban delivery vehicles.



Source: Power Systems Research

2.3. Low Carbon Buses

The UK has three domestic bus manufacturers which although they do not manufacture engines and gear boxes, do design the whole bus and retain much of the added value in the buses they produce. The major components are built on the basis of demand across Europe to achieve economies of scale and research and development is done in conjunction with that for freight vehicles.

Technology Pathways

There are a number of potential technology pathways which may lead to significant carbon dioxide emission reductions. The most promising technologies investigated by the Group are shown in Appendix I along with estimated costs, fuel consumption and carbon dioxide emissions.

There are three core technology types which are capable of achieving the low carbon target of a 30% reduction in carbon dioxide compared to Euro 3 buses are:

1. Internal combustion engines using renewable fuels (bio-diesel, bio-gas or renewable hydrogen)
2. Hybrid vehicles (using internal combustion or fuel cell as the prime mover)
3. Battery-electric

There are also a number of enabling technologies (Appendix II) which by themselves could deliver a significant reduction in carbon dioxide and combined with other technologies could deliver up to 50% reduction compared to the original Euro comparison baseline. These include; stop-start, continuously variable transmissions, regenerative braking, energy storage devices and SCR NOx abatement technology that allows optimum engine efficiency.

Demonstrations of Low Carbon Buses in the UK
To date there has been very limited demonstration of low carbon technologies in buses in the UK, and there is limited knowledge of demonstrations elsewhere in the world. Consequently services have been severely constrained and it has not been possible to resolve issues such as availability, reliability and maintainability of even prototypes, not necessarily pre-production components, which are the key to successful commercial bus operation. Current demonstrations include:

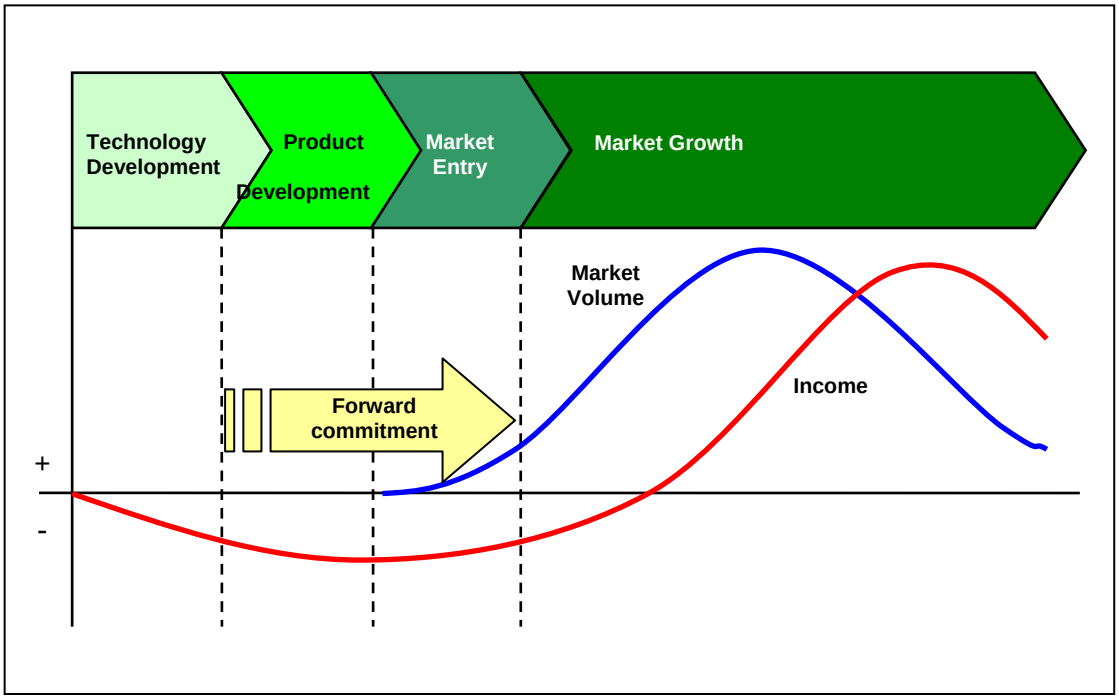
- London – 3 hydrogen fuel cell buses developed by Daimler-Benz / Ballard
- Manchester, Bristol & London – 6 hybrid buses developed by Eneco (now TTL)
- London – 6 hybrid buses developed by Wrightbus
- Mersey Travel – battery electric, CNG, LPG developed by various companies
- Newcastle – 10 hybrid buses powered by gas turbine developed by Designline

Previous trials of alternative technology have shown poor reliability and high costs and as a consequence bus operators are cautious about the prospects for any new technology. Some technology options have yet to be demonstrated as funding for such proof of concept was stopped in April 2003.

To tackle this and provide strong evidence of how different technologies will perform a large demonstration of low carbon bus technology should be conducted in the UK. This should be combined with a campaign to disseminate the results to all interested parties. In addition a study tour of key bus demonstrations in the rest of the world would assist UK bus operators and government officials in assess the potential for market transformation.

2.4. Procuring Innovation & Forward Commitment

Innovation Process
The innovation process to bring low carbon driveline technologies to market is high risk for both the manufacturer and the operator. This is particularly the case during the product development and market entry phases during which securing development finance can be very difficult and consequently unit costs are high and reliability of product low.

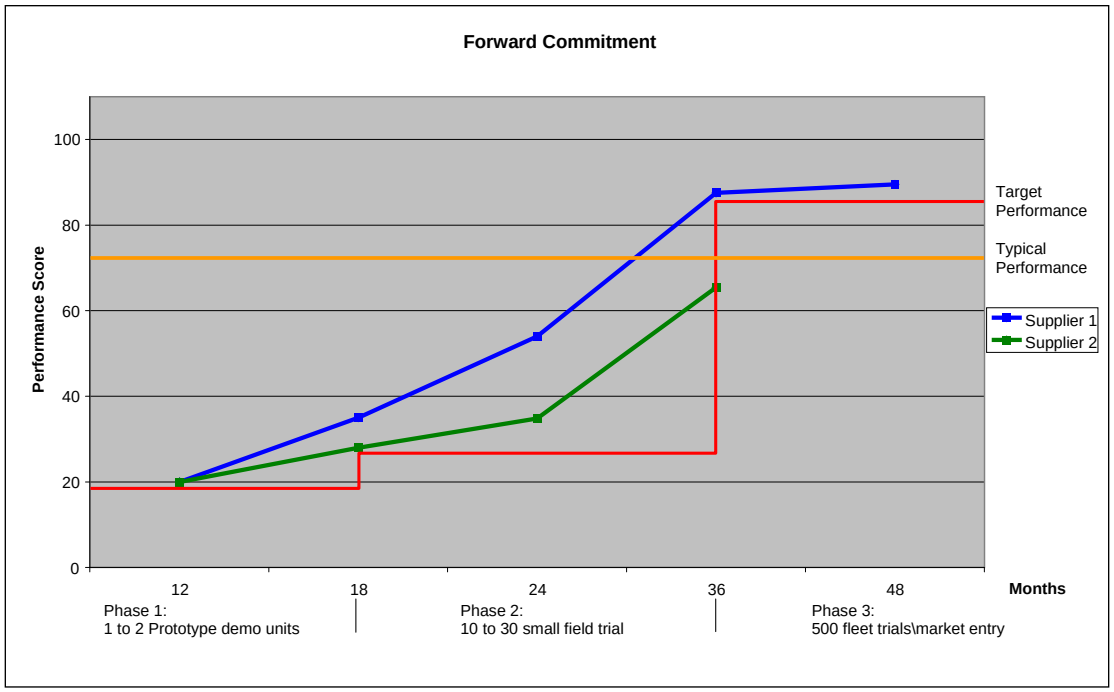


Forward Commitment Proposition

The forward commitment is intend to help secure investment by offering a baseline volume of purchases for technologies which achieve acceptable performance criteria. The basic elements of the Forward Commitment are that:

- An organisation commits to purchase a pre-defined quantity of a product\technology currently under development but not yet available as a commercial offering. This is the Forward Commitment.
- The commitment is for a future date and is based on a specified product performance being achieved
- The supply of a product meeting this performance specification within the agreed timeframes and framework triggers the Forward Commitment
- The Forward Commitment is for a quantity of product sufficient to encourage supplier investment to ensure economies-of-scale
- The Forward Commitment is enacted within the usual framework of best practice public procurement

The Forward Commitment can be made by a single organisation or a group acting to purchase vehicles together through a competitive tendering process to meet an unmet need or demand. There is a legally binding agreement between the purchaser/s and the supplier. A forward commitment may be entered into with one or more suppliers.



The manner in which a Forward Commitment would work can be explained in conjunction with the diagram above. Bus purchasers will express a target performance target, which incorporates environmental performance, which is in excess of the typical performance of existing buses. However the performance of buses fitted with low carbon drivelines in the early stages of product development will perform less well than the typical performance of existing drivelines e.g. in terms of reliability or other operational criteria. The Forward Commitment provides a basis for demonstrating improved performance through a structured programme, in which performance targets for each phase of the programme are predetermined. Suppliers who successfully achieve the targets are allowed to proceed to the next phase. Successfully achieving the final target will trigger the commitment from the procurer to purchase a significant volume of buses.

The diagram above gives an example of a three phase Forward Commitment, with performance targets set for each phase, the last triggering a commitment to purchase the bus in significant volumes. Supplier 1 achieves the performance targets for each phase and successfully triggers the forward commitment. While supplier 2 achieves the target performance in phase 1 and 2 but fails to achieve the final performance target and so does not trigger the volume purchase of it's product.

Unmet Need / Demand

In the bus market the unmet need or demand is assumed to be a public good to reduce the environmental impact of buses on the global and local environment.

This demand can best be expressed by public authorities (PTAs and local transport authorities) rather than bus operators or passengers.

Because of this it is expected that a Forward Commitment for low carbon buses would have to involve the public authorities in some form. The most likely form being through back to back contracts, for the provision of bus services by a local authority and the purchase of buses to operate the service by the bus operator. This might restrict the market outside London in which a Forward Commitment could be employed.

3. Methodology

The study is a combination of literature and documents reviews, direct discussions with stakeholders from all sectors of the bus industry, together with the required level of analysis of data and information to achieve the desired outcomes. The aim is to provide the Low Carbon Vehicle Partnership and its members with a document which will allow the Department for Transport (DfT) and the managing agent for the Low Carbon Vehicle Procurement Programme, as well as local and regional authorities, to assess the ability of joint procurement through a Forward Commitment to proceed with confidence in the support and development of low carbon buses.

There are four key elements to the methodology:

3.1. Policy Drivers and Customer Interest

Existing and forthcoming policy drivers were assessed from published information on legislation, regulations and consultations arising from the European Commission and UK Government sources. These included:

- The UK Energy White Paper and draft Climate Change Bill
- The DfT Low Carbon Transport Innovation Strategy
- The DfT document "Putting passengers first"
- The DfT draft Local Transport Bill
- UK Renewable Transport Fuels Obligation
- EU Directives and policies in relation to alternative fuels, transport energy efficiency and carbon management

Customer interest was assessed from discussions with leading passenger transport authorities, such as Transport for London (TfL), Merseytravel, and Greater Manchester PTE and local authorities. It was assumed that public bodies would be taking the lead in specifying and/or procuring low carbon buses as part of the Forward Commitment. Issues to be covered included:

- Local Authority Legal Powers (Transport Acts 1995, 2000)
- Public Service Agreements
- Local Authority Carbon Management programmes and Local Plans
- Role of Forward Commitment and joint procurement programmes
- Other project initiatives and funding opportunities (eg the EU 7th Framework Programme)

In order to elicit views a workshop was held to allow the provisional recommendations to be discussed by PTEs, local authorities and other stakeholders.

EU State Aid rules were taken into account where possible although we are aware that interpretation of State Aid rules are sensitive to the specifics of programmes and so broad assessment is of limited value. The announcement of the formal consultation on the Bus Subsidy came at the very end of the project and so it was only possible to incorporate it to a limited degree retrospectively.

3.2. Financing and contractual arrangements

The contractual structure to deliver a low carbon bus forward commitment was developed through a process of consultation with all partners within the bus sector building on the existing expertise throughout the industry.

Organisations consulted included private sector bus companies, and major financing and leasing institutions involved in funding commercial vehicles. In addition public service agreements and bus company procurement tenders were examined in order to establish current practice in these arrangements. By working with these and other organisations the following was formulated:

- The suitability of current procurement practices to implementing a Forward Commitment
- A proposed framework for implementing a Forward Commitment
- Funding streams required during a Forward Commitment
- Alternative strategies for providing financial support in order to maximise cost effectiveness.

We investigated what financial incentives to encourage bus operators to invest in low carbon vehicle technologies are available. Without any incentives, the commercial case for bus operators to purchase innovative designs of low carbon vehicles is marginal and accordingly the sector needs public support to increase the market share of low carbon buses and reduce unit costs. The limitations of the State Aid funding rules mean that a maximum of 30% funding could be available if the Low Carbon Vehicle Procurement programme was extended to private sector bus operators.

Possible financial incentives could include:

- Capital allowances
- Grant schemes
- EU R,D&D programmes
- Emissions Trading Scheme
- Renewable Transport Fuel Certificates

A range of financial measures were assessed in order to establish potential sources of funding for the Forward Commitment.

3.3. Low Carbon Bus Specification

A workshop approach was used to develop the low carbon bus specification because individual interviews with around 7 OEMs would not be an efficient use of time and resources. We invited to the workshop all the relevant OEMs, Local Authorities and bus operators. We aimed to attract at least four of each type of organisation to attend the workshop, this was exceeded and demonstrated a high level of interest in this approach particularly from PTAs. In addition representatives from the DfT, TfL, LowCVP, the Confederation of Passenger Transport and the TRUS consortium were also invited to the Workshop which was hosted by the DfT.

An initial draft specification was presented at the Workshop. This was based upon discussions with TfL, MerseyTravel and the TRUS consortium. This draft specification was amended and refined by the Workshop. Further feedback from bus manufacturers and system suppliers was also obtained before finalising the proposed specification.

3.4. Client supplied documents

The project relied upon the kind support of Transport for London and Merseytravel in providing details of their specification and current procurement practices as a basis for development, for which we kindly thank them. In addition our thanks go to Transport for London and Millbrook for supplying details of the MLTB test cycle for buses.

In addition the LowCVP gave the project access and clearance to use minutes and relevant working documents from the Bus Working Group and the Procurement sub-group as background material for the study.

4. Stakeholder Interest

4.1. Introduction

The objective of this part of the feasibility study was to establish the level of customer interest in low carbon bus procurement and whether there is an unmet demand which has the potential to be realized. It is assumed that the demand would come from public bodies such as Passenger Transport Authorities (PTAs) or local transport authorities rather than bus operators.

4.2. Customer Interest

Early trials and demonstrations

During the 1990s and early 2000s, there have been several trials and demonstrations of buses using alternative fuels or power systems. These have included:

- Dennis Dart and Volvo CNG-fuelled vehicles in Southampton, Merseyside and the West Midlands;
- Electric mini-buses for community transport in Camden;
- Wrightbus electric hybrid mini-buses in Bristol;
- Mercedes-Benz electric hybrid vehicles in Portsmouth;
- Technobus Gulliver electric vehicles in Merseyside;
- Hydrogen fuel cell buses operated in London as part of a Europe-wide demonstration project.

These trials have often involved collaboration by local authorities with manufacturers and bus operators in order to examine operational performance, costs and other technical issues. None of them have involved large-scale dedicated fleets of low carbon buses. Funding for some of these R&D or demonstration projects has come from either EC programmes or the Energy Saving Trust. Operating experiences from most of these projects have been reported[1], and valuable lessons learnt. These trials have indicated that the eventual market for alternative fuels and low carbon technologies in bus operation will be strongly influenced by:

- The predicted costs and benefits to the customer and operator being commercially acceptable;
- Fuel tax and subsidy arrangements applicable to the UK bus industry;
- Whether there are access restrictions to some urban centres for all but low-emission vehicles;

[1] "The route to cleaner buses, a guide to operating cleaner, low carbon buses", Energy Saving Trust/Clear Zones 2003.

- How much increasingly stringent European emissions control legislation may favour alternative fuels;
- The extent of other benefits from alternative clean fuels such as performance improvements, quiet operation and improved fuel economy.

Although alternative fuels and vehicles offer the potential for emission reductions and, in some cases, performance improvements, the economic incentive to operate cleaner fuel buses is very limited. One of the main financial barriers is the direct grant support through BSOG for fuel consumption. This topic is examined further in later sections of this report.

Participation by local transport authorities and PTAs

Local transport authorities and PTAs would have to make the decision to encourage low carbon buses as part of an environmental policy initiative, and they would have to recognise that there would be capital cost and operating cost implications for the bus operator. A means of reducing the financial risk to the operator would have to be found, perhaps involving risk sharing with the local authority and other public or private partners.

Nevertheless, during discussions at the stakeholders' workshop in the preparation of this study, several PTAs have indicated their willingness to participate in developing a low carbon bus project. The Passenger Transport Executive Group (PTEG) is also prepared to be involved. This level of interest is encouraging, in that there is a demand from a selection of the key public bodies likely to take forward an initiative on low carbon buses. Further exploration is needed in order to identify more clearly how this interest can be built upon, and to establish how widespread the market demand might be. One means of doing this is to undertake a more extensive telephone survey of PTAs, local transport authorities and bus operators, based on the findings of this feasibility study including the low carbon bus specification and the forward commitment process.

Hybrid buses in London

As outlined above, regulated bus operations in London are subject to different controls. Transport for London is responsible for tendering services in the capital, and can specify features such as emissions and fuel standards of the vehicles used on the tendered routes.

It is understood that TfL is planning to introduce fleets of hybrid buses, commencing in late 2008. A first phase of 50 vehicles will be followed by a further 300-500 buses to be procured between 2010 and 2012. The first phase vehicles will comprise a variety of hybrid/low carbon technologies which will be assessed in field trials using real-life routes and operations. The best types of low carbon buses will form the basis for future orders. Additionally, TfL has ordered 5 hydrogen fuel cell and 5 hydrogen fuelled internal combustion engine buses as the second phase of their R&D / demonstration assessment of hydrogen fuelled vehicles.

There will be important results emerging from the TfL hybrid buses that could be used for the benefit of other local transport authorities and PTAs. However, it should be recognised that TfL will be examining one set of low carbon bus options, namely hybrids, and there are other options which could be examined in field trials and demonstrations.

4.3. Conclusions and Recommendations

Conclusions
Given the level current regulatory regime and form of bus subsidy, the level of interest in low carbon buses evidenced through existing demonstrations and the level of interest shown in collecting information for this study was surprisingly high. This needs to be investigated and quantified in a systematic manner to determine the extent of market demand for low carbon buses.

Recommendations
It is recommended that a strategy for the LowCVP in taking forward a low carbon bus initiative should comprise the following elements:

1. Undertake a telephone survey of PTAs and a representative sample of local transport authorities in order to establish more clearly the extent of market demand for low carbon buses;

2. Undertake a telephone survey of the five large bus operators and a representative sample of smaller regional bus operators in order to establish more clearly the extent of market demand for low carbon buses.

5. Policy Drivers

5.1. Introduction

The objective of this part of the feasibility study was to identify the existing and potentially forthcoming national policy drivers available to create or support a market for low carbon buses, particularly outside London.

5.2. "Low Carbon" Policies

The Government is taking active steps to promote and stimulate a "low-carbon" economy across the main energy using sectors in order to reduce the UK's emissions of greenhouse gases. As a result there are several existing and forthcoming policy drivers from national Government which can help to create or support a market specifically for low carbon buses. These include legislation, regulations and on-going consultations. This section contains a brief overview of these policy drivers, and their implications for PTA and local transport authority involvement in low carbon buses.

5.3. Government policy and legislative framework

Climate change and CO_2

Current UK Government policies include:

- proposed legislation in the ***Climate Change Bill*** to set binding legal commitments to reduce UK CO_2 emissions;
- the introduction of new measures and the reinforcement of existing fiscal incentives for all sectors of the economy to contribute to CO_2 reduction;
- stimulation of the transport fuels market to introduce renewable transport fuels such as biofuels through the Renewable Transport Fuels Obligation;
- communications campaigns to highlight to consumers the choices they can make in helping to reduce their individual CO_2 "footprint";
- long-term strategies to support national activities in R&D and demonstrations of low carbon technologies, including a ***Low Carbon Transport Innovation Strategy***.

The European Commission is also active in this field, and has introduced a number of Directives aimed at stimulating Member States to take domestic measures on CO_2 reduction. These actions are intended to help the EU as a

whole to achieve the Kyoto targets for greenhouse gas reductions by 2012, and include new proposals to reduce EU greenhouse gas emissions beyond 2012.

Transport is currently responsible for almost 25% of UK CO_2 emissions, and its contribution is predicted to increase over time. Over the last decade transport has been the fastest growing source of CO_2 emissions. This reflects the impacts of increased personal mobility and a growing economy on the demand for goods and services. However, the Government has not set individual CO_2 reduction targets for different sectors of the economy because it believes that emission reduction efforts should be first focused on the areas where they are most cost-effective. The Stern Review on the ***Economics of Climate Change***[2] suggested that in the short term many transport abatement techniques may not be cost-effective, but that action is required to contain emissions and to bring forward technologies that can deliver more cost-effective CO_2 reduction in the future. The Government has broadly accepted these recommendations and is developing transport and climate change policies accordingly.

The role of public transport

The Government recognises the important role that public transport has to play in reducing emissions from transport. In December 2006 the Government published proposals for a modernised national framework for bus services, in "***Putting Passengers First***". In May 2007, the Government published a draft ***Local Transport Bill*** which is aimed at empowering local authorities to take appropriate steps to meet local transport needs in the light of local circumstances. The Bill was presented to Parliament in November 2007. The Bill will be progressed through Parliament in the current session, and should become law by the summer 2008.

The Bill proposes to:

- enable local authorities to improve the quality of local bus services*;*
- reform the arrangements for local transport governance in the major conurbations; and
- reform the existing legislation relating to local road pricing schemes.

The Local Transport Bill includes the creation of new duties on Passenger Transport Authorities (PTAs):

- firstly, to take account of any policies announced by the Government which relate to climate change or its consequences and,

[2] The Stern Review is published by HM Treasury at http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change?stern_review_report.cfm

- secondly, to have regard to any guidance on this subject which the Secretary of State may issue.

These two duties would apply to PTAs in carrying out those duties imposed on them under section 108 of the Transport Act 2000. Section 108 of the Transport Act 2000 will be amended to place a more general duty on local transport authorities, including PTAs, to develop policies for the promotion of safe, integrated, efficient and economic transport within their area.

The Bill will also provide PTAs with a power to take any steps which they consider likely to promote or improve the economic, social or environmental well-being of their local community. These powers have already been granted to local authorities by means of Part 1 of the Local Government Act 2000. This clause would allow PTAs to undertake a wide range of activities for the benefit of their local area and to improve the quality of life of local residents, businesses and those who commute to or visit the area.

The Bill includes an important provision to revive a power in the Transport Act 1968, but subsequently prohibited following the implementation of the Transport Act 1985, so as to enable Passenger Transport Executives to purchase buses to let for hire to operators. This would be limited to circumstances where operators are providing services as part of a subsidised services contract or a quality contract.

Other recent Government initiatives

The Government's ***Energy Measures*** report, which was published in September 2007, and to which all local authorities must have regard, contains a chapter specifically on transport. This report contains guidance on how local transport authorities should take account of national climate change objectives, as well as providing advice on influencing transport sustainability. For some local authorities, the mechanism for the provision of public transport will be the PTA. For those covered by a PTA, the local authority can use their influence within the PTA to specify, when contracting out the services, that any vehicles procured are energy efficient. Options mentioned in the ***Energy Measures*** report include electric, hybrid or liquid petroleum gas (LPG) vehicles, or petrol or diesel vehicles that are as energy efficient as possible.

Most recently, the Government published its discussion document – entitled "***Towards a Sustainable Transport System"*** in October 2007. Schemes going forward, subject to affordability and value for money tests, include public transport investment such as bus stations, guided bus and trams, local road improvements which will benefit both freight and passengers, and traffic management schemes including measures to enable bus priority.

Low carbon vehicles

The ***Low Carbon Transport Innovation Strategy*** reflects the important role that new technology will play in delivering carbon reductions in the transport sector over the long-term. The strategy assesses where Government intervention is most usefully focused and sets out a wide range of actions being taken to encourage innovation and technology development in low carbon transport technologies.

New public funding for low carbon vehicles is proposed. This comprises:

- an additional £5M/year to the low carbon transport theme of the Energy Technologies Institute;
- in conjunction with the Technology Strategy Board (TSB), DfT and EPSRC will help finance and develop a new Low Carbon Vehicle Innovation Platform providing critical coordination and up to £30M from 2008/09 for UK technology research aimed at accelerating the development of relevant technology;
- with initial funding of £20M, DfT will develop a new programme of public sector procurement to promote and support low carbon vehicle development, including small fleet demonstrations to provide early markets for new innovative lower carbon vehicle technologies. The first phase of this programme will involve a major procurement by public sector organisations of low carbon vans, together with smaller trials of all-electric vans, hybrid mini-buses and hybrid passenger cars.

In addition to promoting carbon reduction through the application of new technologies, the ***Low Carbon Transport Innovation Strategy*** also mentions the benefits of the Safe and Fuel Efficient Driving scheme (SAFED) as a means of improving energy efficient driving techniques. DfT have recently published the findings of a feasibility study for extending SAFED to the bus and coach industry[3]. Pilot training as part of the study provided strong indication that SAFED would achieve similar results in the bus and coach sector to that achieved in the truck and van sector. The study recommended that DfT to fund a demonstration programme, delivering a network of approximately 300 SAFED Bus and Coach trainers.

5.4. The Role for Local Transport Authorities

As can be seen from the outline descriptions above, there is a wide range of legislation and regulation aimed at stimulating better use of public transport, and supporting low carbon technologies, energy efficient processes and alternative fuels in transport. However, there is no direct and simple power which would enable a local transport authority (outside London) to buy and operate local low

[3] SAFED Feasibility Study for Buses and Coaches, a report by Momenta for DfT, May 2007, published March 2008.

carbon bus services or demand that a bus operator should use low carbon buses. Under deregulation, how a bus operator works in a community is a commercial issue and not one for local authority intervention.

Structure of transport authorities

In London, Transport for London (which is accountable to the Mayor) specifies in detail what services are provided. TfL decides the routes, timetables, and fares – everything down to the colour of the buses. The services themselves are operated by private companies through a competitive tendering process. There is no on-road competition.

In the rest of Great Britain[4] it is a free market – anyone (subject to minimum safety and operating standards) can start up a bus service. Bus operators are free to run whatever services they like, charge whatever fares they like, and use what vehicles they like. Monitoring and regulation of reliability and vehicle cleanliness is effectively minimal. Although in theory it is a competitive market, in reality the majority of bus services are provided by five large companies who rarely compete directly against each other.

Since 1968 seven Passenger Transport Authorities have been created by statutory instrument:

- Greater Manchester;
- Merseyside (now operating under the name of 'Merseytravel');
- South Yorkshire;
- Strathclyde (operating as a Regional Transport Partnership);
- Tyne and Wear (now operating under the name of 'Nexus');
- West Midlands (now operating under the name of 'Centro');
- West Yorkshire (now operating under the name of 'Metro').

In these PTA areas the big five bus companies – Arriva, National Express, First, Go-Ahead and Stagecoach – operate about 90% of services.

Local transport authorities are only allowed to fill in gaps where there is an inadequate commercial service. Where bus routes are socially necessary but not economic, local authorities can put routes out to tender. Some 15% of bus routes outside London are allocated this way. Specific routes such as Park and Ride routes are also put out to tender by local authorities. The tender specification can set conditions concerning the provision of the service. A careful balance is needed as, however, any too stringent conditions such as insisting on low carbon buses, might generate a Judicial Review. These local authority funded routes are operated by private companies through a competitive tendering process.

[4] In Northern Ireland, bus services are regulated.

Legal powers

The existing legal powers for local authorities relating to transport are closely defined by Government and there is little scope for flexibility in bringing about change in their areas. The ***1985 Transport Act*** generally precludes local authorities outside London from operating regular bus services. This means local transport authorities are not bus operators in their own right and, generally, do not procure new buses. It is the bus operators, in the main private sector companies, that operate and run bus fleets. Nevertheless, local authorities can and do play significant roles in local public transport. Local authorities have a transport planning function and have influence in the delivery of public transport in their areas. Some local authorities have established partnerships with bus companies to introduce low carbon buses in specific cases, for example in Merseyside and in Winchester.

Nevertheless, the existing legislation includes two provisions that are potentially of interest. These are *quality partnership schemes* and *quality contract schemes*.

- A quality partnership scheme is a scheme made by a local transport authority under which that authority provides particular facilities at specific locations along the routes used by local bus services, and operators of local services who wish to use those facilities agree to provide services of a particular standard.

- A quality contract scheme is a scheme under which a local transport authority determines what local services should be provided in the area to which the scheme relates, any additional facilities or services which should be provided in that area, and local services may only be provided in that area in accordance with "quality contracts" entered into by a local authority with a bus operators following a competitive tendering process.

Voluntary partnerships are already widely used, but local transport authorities have been reluctant to enter into statutory partnerships. However, the first statutory quality partnership scheme (in North Sheffield) was set up in late 2007. This specifies environmental standards for buses to use low emissions Euro III engines in the relevant services. Likewise, no quality contract schemes have been implemented due in part to the difficulty of taking a scheme through the statutory approvals process.

Another approach has been adopted by Merseytravel, which has established a bus station facility charging policy. This has the goal of helping to improve the environment in Merseyside by giving a discount on the facility charge to bus operators in proportion to the percentage of that operator's fleet which meet or exceed the Euro III emissions standard. This has the effect of supporting Merseytravel's corporate goals of improving quality of life and reflects their ongoing investment in bus stations whilst remaining consistent with the needs of the market.

Opportunities for local transport authorities

Despite the restrictions of the 1985 Transport Act, there are several other opportunities which local authorities may be able use. The powers given to local authorities are primarily focused on air quality, social deprivation, economic development and integrated transport planning:

- ***The Environment Act 1995*** gives power to local authorities to declare Air Quality Management Zones which in theory could lead to limiting access to specific types of vehicles.

- Local Transport Authorities under the ***Transport Act 2000*** are required to produce a *Local Transport Plan*. This plan is developed in conjunction with the local authorities, local bus operators and representatives of local bus users. This legal power could be used as a basis for getting low carbon buses on tendered routes.

- The Transport Act 2000 also established the concept of ***Quality Partnerships*** and ***Quality Contracts*** with the aim of improving the bus service offer in an area.

- The ***Local Government Act 2000*** gives local authorities the power to do anything which they consider is likely to achieve the promotion or improvement of the economic, social or environmental well being of their area. In theory a local authority can incur expenditure on low carbon buses provided that it does not break an existing primary law or regulation and that it benefits all or part of the local authority area and its residents.

- Planning obligations or ***Section 106*** powers are legal agreements under the ***Town & Country Planning Acts***. Local authorities can require developers to undertake specific actions to exploit the financial benefit generated by the change of use.' This power could be used to support the introduction of low carbon buses but the scope is limited not only by the Transport Acts but also by restrictions on state aid to private sector companies[5].

Making use of the Local Transport Bill

[5] **State aids** include subsidies, grants, loans, procurement orders, tax holidays, cash injections, write-offs etc. There are four tests for state aid:

~ Does the state grant aid or resource private sector actions?
~ Do the actions benefit certain businesses but not all
~ Are the activities tradable [including in theory] amongst EU member states?
~ Do the activities have the power to distort or potentially distort competition?

DfT and OFT have published draft guidance on the Local Transport Bill[6]. This guidance explains that Part 3 of the Bill makes a number of amendments to the provisions on quality partnership schemes and quality contracts schemes in Part 2 of the Transport Act 2000, and to the competition test in Schedule 10 to that Act which, in consequence, would also apply to certain voluntary agreements relating to buses.

Existing legislation, as proposed to be amended by the Local Transport Bill, provides a variety of powers for local authorities who wish to improve the quality of bus services in their areas beyond what the deregulated market would by itself provide. For English local authorities outside London, this 'tool-kit' includes powers to enter or make:

- subsidy agreements with bus operators, where in the absence of subsidy the service would either not be provided at all, or would not be provided to a particular standard (under section 9A of the Transport Act 1968 (for PTAs) or section 63 of the Transport Act 1985 (for other authorities);

- voluntary partnership agreements with bus operators (under the general powers provided by section 111 of the Local Government Act 1972), subject to a revised competition test set out in Part 2 of Schedule 10 to the Transport Act 2000;

- quality partnership schemes (under sections 114 to 123 of the Transport Act 2000);

- quality contracts schemes (under sections 124 to 134 of the Transport Act 2000);

- ticketing schemes which can provide, for example, for joint and through ticketing schemes involving multiple operators (under sections 135 to 138 of the Transport Act 2000);

- concessionary fares schemes that go beyond the statutory minimum requirements (under Part 5 of the Transport Act 1985).

DfT considers that these powers provide a wide range of options for local transport authorities to increase the contribution of buses to meeting local and national objectives for transport. By implication, this means that the national climate change objectives could form part of the local authority actions in promoting low carbon public transport. Making bus services a more attractive alternative to private car use can help to encourage modal shift, contributing to reductions in emissions of greenhouse gases and local air quality pollutants.

[6] The Local Transport Bill - Improving local bus services: Draft Guidance, December 2007, Department for Transport and Office of Fair Trading.

Addressing environmental objectives via the Local Transport Bill
DfT has stated that the tool-kit includes a range of options for local transport authorities to improve local bus travel in their areas. Individual elements of the tool-kit provide opportunities for local authorities to go further in tackling environmental objectives. In particular, DfT suggests that voluntary agreements, quality partnership schemes, quality contract schemes and service subsidy agreements can also specify requirements as to the environmental standards of vehicles used to provide particular services. When designing proposals for agreements or schemes involving environmental factors, local authorities are reminded by DfT that they should consider the benefits and costs that might be involved in taking a similar approach.

Using a Statutory Quality Partnership Scheme (QPS)
The essential feature of a QPS is that the local transport authority provides particular facilities and sets the standard of services to be provided by bus operators as a condition of using these facilities. A local traffic authority can make a QPS only if it satisfies the requirements of the Competition Test in Part 1 of Schedule 10 to the Transport Act 2000. This requires that:

- the Scheme does not have a significantly adverse effect on competition, or
- the effect it has on competition is proportionate to the achievement of one or more of the following purposes;
    - improving the quality of vehicles or facilities covered by the Scheme;
    - securing other improvements to local services of benefit to their users;
    - reducing or limiting traffic congestion, noise or air pollution

There are three distinct stages to the competition test:

- is there a significantly adverse effect on competition?
- is the exercise of the LTA's function with a view to securing one of three purposes specified in Part 1? and
- is the effect on competition proportionate or likely to be proportionate to the achievement of that purpose?

As an example, the DfT guidance considers a QPS which includes increasing the number of buses using environmentally friendly fuels. The objective of this part of the QPS would be to increase the number of buses using greener fuels, such as bio-fuels. This is intended to help reduce pollution. The second stage of the Part 2 test is, therefore, satisfied.

The possible adverse effect on competition in this case would also be raising barriers to entry by raising the cost to actual or potential bus operators using the facilities provided by the QPS. The QPS would require bus operators to agree to the phase in over an agreed period of time more environmentally fuel friendly vehicles. If the cost of adapting buses is low, then the overall reduction in competition is likely to be small and the benefits to consumers likely to outweigh the reduction in competition resulting from the restriction. Hence the third stage would be satisfied. Without the QPS and LTA intervention the phase in of environmentally fuel friendly vehicles may have been longer and less consistent.

However, if the QPS were to require certain types of buses or only new buses to be operated on the route, but this was unnecessary to achieve the environmental goal of lower fuel emissions, then the requirement would fail the third stage of the test. If such measures would provide some small further environmental benefits, it would be a matter of weighing up whether the substantially increased costs, and resulting barriers to entry, could be justified with regard to the small additional benefits to be realised.

As low carbon buses are likely to have a much higher initial capital cost than conventional vehicles, the financial implications of the QPS would need to be examined carefully. It might be important, for example, to consider the life-time costs of purchase, operation and maintenance, and to take into account the residual values. The financial aspects of the forward commitment process are discussed in a later section of this report.

Local Government Performance Framework

The Local Government White Paper (October 2006) set out a new performance framework for local government. The framework comprises 198 indicators covering all Government priorities for local delivery. The aim is for local government to report and/or monitor their performance against these indicators from April 2008. One indicator is the "*per capita reduction in CO_2 emissions in the Local Authority area*" (NI186). DEFRA has published a national dataset of CO_2 emissions calculated for 2005, disaggregated to local authority level, and this dataset will be used as the baseline. The dataset will be updated annually by DEFRA, using a methodology developed for this purpose.

Although local authorities will not be required to carry out specific reporting under this indicator, the intention is that they will use the data on the overall emissions of the areas they serve as part of the process for developing local policies for reducing emissions. Road transport, excluding motorway traffic, is included in the dataset, and is based on traffic flow measurements, traffic composition and standard emissions factors. The *Energy Measures Report*, which identifies the ways in which a local authority can influence greenhouse gas emissions in their areas, is intended as a guide to local authorities in exercising their functions within this performance framework.

5.5. Reform of BSOG

One of the main Government-funded subsidy schemes for bus operators is the Bus Services Operators Grant (BSOG). This pays a rebate equivalent to 80% of the fuel duty incurred by bus operators when they use diesel fuels on a stage service. The rebate increases to 100% when bus operators use bio-fuels. It does not apply to coach travel.

LowCVP in its response[7] to "Putting Passengers First" made out a strong case for reform of BSOG. LowCVP took the view that BSOG provides a disincentive to the adoption of low carbon and high fuel efficient buses. This is because it subsidies the fuel operating cost of the vehicle through the fuel duty rebate, rather than the whole life cost of the vehicle. The Partnership suggested that BSOG should be reformed to be directly linked to bus operators' performance and/or environmental outcomes. Three options were examined, and these were, in order of preference:

1. To replace BSOG with a subsidy based upon passenger-km, which provides an incentive for increasing patronage;

2. Low carbon buses, as defined by LowCVP and the Powering Future Vehicles Strategy, to receive a 100% fuel duty rebate under the existing BSOG;

3. Low carbon buses receive a capital grant to supplement BSOG.

The Transport Act 2000 includes provisions whereby the Secretary of State can devolve the amount of funding equivalent to BSOG to local transport authorities where a Quality Contract is in place. The local transport authority would then provide contract payments to operators based on performance indicators in the area's contract plan. This approach has the potential to make the amount of BSOG funding more effective and targeted. It has the merit of decoupling a major portion of the bus subsidy from subsidising fuel consumption, and has the potential to link it to the achievement of other criteria, such as the use of low carbon buses. However, there have not been any Quality Contracts set up which make use of these provisions, partly due to the legal complexities of obtaining the necessary approvals.

In response to the anomalies arising from BSOG and the concerns expressed by LowCVP and others, DfT has commenced a further review and consultation on BSOG and a formal consultation was announced along with the Budget on 13th

[7] LOWCVP-P-07-03, Low Carbon Vehicle Partnership response to "Putting Passengers First".

March 2008[8]. DfT now recognises that the current policy for paying BSOG for low carbon buses weakens the incentive for the operators to invest in new technology, particularly low carbon buses, such as electric hybrid buses. The consultation seeks views on options for a package of reforms of subsidies for local bus services.

In the short term the proposals in the consultation focus on BSOG and include the following options:

- a distance based BSOG rate for hybrid, and other, low carbon buses to overcome the disincentive that current fuel-duty based BSOG presents; or alternatively for low carbon buses a BSOG rate equivalent to 100% of fuel duty (together these first two proposals help align the subsidy incentive with DfT policies to address environmental objectives)
- devolution of London BSOG to Transport for London (TfL) with a sum equivalent to London BSOG transferred to TfL.
- confirmation of the 2002 commitment that BSOG would be devolved to local transport authorities where, and when, Statutory Quality Contracts are in place

The consultation also seeks views on possible changes in the longer term, which include:

- devolution of BSOG funding to local authorities even where a Quality Contract is not in place
- switching BSOG to a per passenger payment (rather than fuel based, as now).
- exploring more radical options for linking BSOG and concessionary fares reimbursement.

It is understood that some of the shorter term options could be brought into force this year and may assist in providing an unbiased means of providing bus subsidy to low carbon buses.

5.6. Conclusions and Recommendations

Conclusions

The conclusions from this part of the feasibility study can be simply stated. Local transport authorities are constrained by current legislation and there are few direct opportunities for them to specify low carbon buses in their areas. Nevertheless, the broad policy drivers coming from Government are to

[8] Local Bus Service Support – Options for Reform, DfT Consultation Paper March 2008

encourage and stimulate national and local actions to reduce greenhouse gas emissions, and the introduction of low carbon vehicles forms one important part of this strategy. These drivers can be seen in the broad policy initiatives contained in new legislation such as the Climate Change Bill, and in the recent strategy and guidance documents such as the Low Carbon Transport Innovation Strategy and the Energy Measures Report.

Moreover, there is a new enabling environment for local transport authorities, including PTAs, with the forthcoming legislation in the Local Transport Bill. Once enacted, this should give more flexibility for introducing low carbon buses. In particular the revival of powers for PTAs to lease buses to operators that are providing services under a subsidised service contract or a quality contracts scheme could be a focus for a PTA to buy and then lease low carbon buses in appropriate situations.

It can be seen that the powers granted to PTA's and to a lesser extent local transport authorities would make low carbon bus procurement outside London possible on subsidised routes, contracted routes, in-house services and through Quality Partnerships and Contracts.

This opportunity is independent of any BSOG reform but the cost-effectiveness of low carbon buses would be an additional barrier, because the lack of BSOG reform would affect the viability of low carbon buses. This is covered in Section 7.

If we assume that an alternative to BSOG for low carbon buses could be introduced later this year, the best option would seem to be a flat rate per mile. The question would arise as to the recommended level of the flat rate and which buses are eligible to qualify as "low carbon". Further consideration of this point is given in the section 7.

The main opportunities for PTA and local transport authority involvement could include:

- Subsidised routes which are socially necessary but not economic;
- Park and Ride services;
- In-house transport such as school buses and social services;
- Quality partnerships/quality contracts, supported by BSOG funds.

The potential pitfalls in this approach include:

- State Aid restrictions on the use of public funds to support commercial operators;
- Whether local transport authorities and bus operators which are entering into, or are participating in, a quality partnership scheme or other bus partnership agreement, comply with competition law;

- The application by the District Auditor of best value criteria in judging local authority expenditure.

Care will be needed to make use of the new powers in the Local Transport Bill (once enacted) so that any proposals are fully costed, with evidence that they can be funded, and that they are in the public interest and represent good value for money.

Recommendations

It is recommended that a strategy for the LowCVP in taking forward a low carbon bus initiative should comprise the following elements:

1. Develop a strategic partnership with the PTAs and PTEG, and leading local transport authorities, in order to develop the ideas from this feasibility study further, including the possibility of a non-London based approach to specifying and procuring low carbon buses;

2. Lobby DfT further for BSOG reform as already proposed by LowCVP;

3. Include bus driver training, via an activity such as SAFED, in the development of a fleet procurement programme;

4. Discussions with DfT to promote the case for low carbon buses as part of the Low Carbon Vehicle Procurement Programme.

6. Contractual Issues

6.1. Introduction

The objective of this part of the feasibility study was to establish the contractual structure which would be required to deliver a low carbon bus forward commitment.

6.2. Regulated and unregulated operations

London and Transport for London (TfL)
In London, Transport for London (which is accountable to the Mayor) specifies in detail what services are provided. TfL decides the routes, timetables, and fares – everything down to the colour of the buses. The services themselves are operated by private companies through a competitive tendering process. There is no on-road competition.

Some 8,200 buses operate throughout London and TfL through its tendering requirements has significantly reduced the environmental impact of these vehicles. In addition TfL has tested and demonstrated a number of new bus technologies, and is currently following a strategy to demonstrate and then introduce low carbon buses into the London fleet. The strategy will deliver a increasing number of low carbon buses in operation in London through the following procurement profile:

- December 2008 60 Hybrid buses
- March 2010 100 Hybrid buses
- March 2011 100 Hybrid buses
- March 2012 100 Hybrid buses

If successful then from 2012 all bus purchases will be hybrid technology. In addition TfL has currently got on order a further 10 buses based upon low carbon technologies; these vehicles are based on fuel cell/hybrid platforms and are expected for deliver between 2009 and 2010.

The first phase of vehicles ordered for December 2008 deliver are based on a variety of technology platforms and will be subjected to intense scrutiny through early 2009; the purpose of this is to establish the most appropriate technology solution for London. Once this has been established then this technology platform will be used as the basis for future tenders.

TfL is unique in that they have the ability to influence their supply chain directly as all routes are regulated and this means that TfL are able to determine the vehicles being used across the fleet.

The only legislative requirement is the process of going out to tender for the route operator. These operator bids state the vehicle to be used and specify the overall contractual performance including environmental aspects.

TfL have a significant impact on the overall UK bus population as many of the bus operators who operate the London contracts will purchase vehicles new and then pass these vehicles out to the regions at the end of the 5 to 7 year contract. This means that buses operated in London serve the balance of their useful lives, average 10 years, around the UK on unregulated routes. This effect means that the TfL procurement programme scheduled between 2008 and 2012 may see low carbon hybrid buses being transferred around the UK from 2013 onwards.

One issue that needs to be taken into account with TfL is that the drive cycle being utilised for London may not be suitable for regional operations where drive cycle patterns may be significantly different.

Unregulated bus operations
Outside of London, with the exception of Northern Ireland, there is free competition for bus services, subject to minimum safety and operating standards. Bus operators are required to register services with the Traffic Commissioner giving 56 days notice of intention to set up or cease to operate a service and provide information on the proposed route. Other than this bus operators are able to establish routes, control fares, determine which vehicles to employ on a route.

In the major conurbations public transport is co-ordinated by the Passenger Transport Executives (PTE) who are responsible to the local authorities in their area, via the Passenger Transport Authority, and act in partnership with private operators to provide public transport in their region. (See section 5.4 for further details).

Local Authority Controlled Routes
The 1985 Transport Act generally precludes local authorities from operating regular bus services. As a result local transport authorities are only allowed to fill in gaps where there is an inadequate commercial service. Where bus routes are socially necessary but not economic, local authorities can put routes out to tender. Some 15% of bus routes outside London are allocated this way. Specific routes such as Park and Ride routes are also put out to tender by local authorities. These local authority funded routes are operated by private companies through a competitive tendering process.

6.3. Forward Procurement

The proposition of using a Forward Commitment strategy to drive innovation in low carbon buses raises issues that will need addressing in order to make the process viable. Until there is a satisfactory solution agreed by all parties these

issues may well present barriers to the introduction of low carbon buses moving forward. The issues faced by each stakeholder are summarised below and then discussed in detail;

- Bus Operators
  - Increased purchase cost
  - Increased maintenance time and cost
  - Risk of battery/super capacitor lifespan
  - Risk of vehicle downtime
  - Residual value at end of life
  - Guaranteed buy back - residual
  - Continuity of fiscal support and taxation
  - Effect of BSOG on vehicle operating costs
  - Future legislation and fiscal framework
  - Unknown impacts on VOSA regulations

- Bus Manufacturers
  - Reliability of market pull
  - Warranty on vehicle/technology
  - Return on R&D investment
  - Liability for technology failures
  - Battery and super capacitor lifespan
  - Contractual issues with operators

- PTA/Local Authorities
  - Strategic Quality Partnerships
  - Vehicle downtime on routes
  - Operator contract performance
  - Impact of conditions imposed by Traffic Commissioners

6.4. Bus Operators

Increased purchase costs and whole life costs
The bus operator is faced with significant increased capita cost with the purchase of a low carbon bus. Typically the additional cost for a hybrid bus can be in the order of £100,000 additional cost, partly due to component costs, R&D being recovered over small volumes and influence from the North American market, which is highly subsidised.

This is combined with residual values being worse than traditional diesel buses. When you calculate the whole life cost (excluding fuel costs) the increased purchase cost combined with the lower residual mean the operating cost for hybrid vehicles will be substantially higher.

The only mitigating factor on this is that the fuel savings that should be found with hybrid vehicles should counter these additional costs, depending on the treatment of BSOG with low carbon buses.

In theory BSOG in its current format should be neutral between a diesel hybrid bus and a diesel fuelled conventional bus as the hybrid vehicle will use BSOG supported diesel fuel. However the ratio of fuel to operating cost will be lower and this will have the effect of distorting the whole life cost when fuel is included.

In order to assist the bus operator the following should be considered:

- Purchase grants on low carbon should be considered
- Increased subsidies should be allowed for bus operators using low carbon technologies
- Reduced costs for using Bus Stations and facilities should be incorporated for low carbon buses
- BSOG should be amended to an energy or energy efficiency base
- Residual values could be underwritten until the market pull creates genuine residual value increases for low carbon buses

Increased maintenance time and cost

New technologies are going to require increased maintenance times and costs, these costs will be carried by the bus operator and built into their contract calculations. It is crucial that the bus manufacturers ensure that the servicing requirements of new technology are optimised to the lowest levels and that any timings and costs are underwritten. The following needs to be considered:

- Manufacturers should underwrite and produce clear guidelines and costs for all servicing and maintenance issues.
- Sufficient training and support must be in place from manufacturers.

Risk of battery/super capacitor lifespan

There is a high level of risk associated with the lifespan of both battery technologies and super capacitors and many operators are cautious about this impact. As technology develops these issues will reduce but at the moment the following should be considered:

- Batteries and capacitors may need to be owned by manufacturers and leased to operators. This will reduce the risk to operators but will have an impact upon the manufacturers cost base.

Risk of vehicle downtime

Experience to date has demonstrated that new technology vehicles suffer from higher levels of vehicle downtime. This clearly has impacts on operator route reliability and costs. The effect of this is often that operators need to have

additional resources to allow for this eventuality and this has an impact on contract costs. The following needs to be considered:

- The contractual agreements between manufacturers and operators needs to make provision for vehicle performance guarantees, if a vehicle fails to meet agreed performance KPIs then the cost impact needs to be underwritten.
- The agreements between the PTA/LA should be flexible enough to allow bus operators to operate standard diesel buses on low carbon routes where the manufacturer KPIs have been breached.

End of life residual values

Work needs to be undertaken to underwrite the residual values of low carbon buses to support the market until market pull builds the residuals to acceptable levels. The residual has an impact regardless of the funding method incorporated by the operator and will dictate the overall operating cost of the vehicle/route. The supporting of residuals can be done by:

- Financial support from Government through subsidy to underwrite the residual value of vehicles should be considered. This would be a short term requirement until market pull and product reliability increases residuals to market levels
- A possible solution to residual value issues would be for manufacturers to provide guaranteed buy backs on vehicles at agreed terms. For instance if manufacturers bought vehicle back at 5 years, they would be refurbished and receive technology updates before being resold to the market: this would serve to provide underwritten costs for 1st phase operators and cheaper access to technology for 2nd phase operators.

Continuity of fiscal support and taxation

The future of the low carbon bus market depends heavily upon the guarantee continued support through the next 10 to 15 years. The fleet industry needs to be able to produce long terms plans and to be able to depend upon the support of the market and Government through fiscal structure, taxation and subsidy.

BSOG and its effects

As mentioned above the issue of BSOG needs resolution without delay. The current BSOG structure support diesel fuelled vehicles and discriminates against all other technologies and fuel types. This is serving to inhibit the low carbon bus market and act as a barrier to greater investment by manufacturers and operators.

The solutions proposed in the Bus Subsidy consultation issued by DfT in March have the potential to overcome this issue in the short term, with an appropriate flat mileage based subsidy or in the medium term through either the adoption of dispersing the bus subsidy to SQP or through a more fundamental reform of bus

subsidy. What ever the solution, the important thing is to provide a balanced and uniform support for all fuels and technologies.

Future legislation and fiscal framework
The continuity of legislation and fiscal support is crucial to the future of low carbon buses. Policy, taxation and subsidy support must be based upon long term, phased and structured plans that all serve to provide a pull to the bus sector. This might include:

- Financial support for the purchase and acquisition of low carbon technologies.
- Underwriting of residual values for operators/manufacturers.
- State Aid approval for support for commercial enterprise during the demonstration phase of the technologies.
- The introduction of "best value" principles in to public procurement and expenditure.
- Taxation measures favouring low carbon technologies.

Independent support and regulations
Support from an independent body for bus operators could be crucial to the expansion of low carbon buses throughout the UK. Bus operators need a centre of excellence for advice, support and guidance relating to the introduction and application of low carbon technologies. This could be provided by Cenex or, given extra resource, VOSA could be the delivery point for this support.

6.5. Bus Manufacturers

Reliability of market pull
For vehicle manufacturers to continue to maintain and increase the levels of R&D needed to develop best in class low carbon buses it is crucial that there is sufficient market pull to produce a sufficient return on investment (ROI) for manufacturers. With the market in its current state the only way this is able to happen in the short term is for a Forward Commitment strategy to be adopted. The setting of agreed standards amongst the bus operators and PTA's, combined with agreed forward ordering based upon pre-agreed KPi's would give manufacturers the ROI needed to invest.

Without this sizable market pull during the next decade, there is unlikely to be sufficient demand to secure the investment needed to produce vehicles fit for the market need.

Warranty on vehicle/technology
Manufacturers need to consider more stringent warranty issues relating to low carbon buses moving forward. These new technologies bring concerns from operators that need to be addressed by the manufacturer. Issues such as:

- Engine and drivetrain – including motors, batteries and super capacitors
- Warranty against vehicle downtime outside agreed parameters

Return on R&D investment
As discussed under market pull the manufacturer needs market pull to be able to justify the necessary investment in research and development. To be able to kick start the low carbon bus sector in the short term with sufficient invest to deliver mass market vehicles at a reasonable costs will require the reassurance of a sizable market. This is only likely to be delivered through a forward commitment strategy bringing together procurement from bus operators across the UK and possibly Europe.

Technology reliability and support
Manufacturers have to be able to make provision for technology and parts failures both down to them and also outside of their control. The warranties and guarantees provided with low carbon vehicles will need to be robust enough to protect vehicle operators under all circumstances.

This will require significant work with suppliers and manufacturers of all components to low carbon bus manufacturers and robust and creative support mechanisms.

Bus operators need to be protected against vehicle downtime and lack of vehicle performance against agreed KPi's. This will require new and innovative guarantees and warranties that may require some degree of fiscal support.

Contractual issues
As indicated in the section above if the bus operators are to invest in low carbon technology the manufacturer is going to be called to account on issues including the following:

- Vehicle warranty and support extended to longer terms
- Environmental and fuel consumption performance against given KPi's
- Battery and super capacitor life guarantees
- Leasing of batteries and super capacitors
- Engine and drivetrain warranty
- Vehicle downtime undertakings
- Residual value undertakings
- Parts availability for systems
- Training and support
- 24/7 maintenance and engineering support

6.6. Passenger Transport Authorities

To support the manufacturers and operators the PTA's are going to need to provide new levels of flexibility and support such as:

Strategic Quality Partnerships (SQP)
These SQPs would establish a meaningful partnership between the Local Authority, the PTA and the vehicle operator. To enable a route operator to invest in enhanced low carbon vehicles the operator needs to have the financial and operational security that the route will remain cost effective for the duration of the contract; if other operators are allowed to move into a route after investment has been made the financial viability of that route is weakened for the original operator. This acts as a key barrier to stop operators investing in low carbon technology. The SQP would restrict the ability of other route operators in "elbowing" in on the route and reducing the commercial viability of the route.

Vehicle downtime on subsidised routes
Where a route dictates the use of low carbon buses the PTA may need to be more flexible in allowing non compliant standard diesel vehicles to be used by the operator where vehicle failure makes the low carbon bus unavailable. This should only be allowed where the failure of the low carbon bus has fallen outside of the normal agreed KPIs from the manufacturers.

Operator contract performance
The PTA needs to agree contract performance standards with the operator that are fair and equitable to both parties. These should include:

- Environmental performance
- Fuel and energy performance standards
- Reliability and down time limits
- The use of telematic solutions to manage both vehicle and driver

6.7. Financing buses

The bus industry generally purchases buses outright with only around 30% of buses being funded though funding arrangements. Of these funded units around 90% are funded over 5 years through finance lease arrangements with specialist leasing companies.

The leasing industry is faced with all the same issues as the bus operators in setting leasing rentals as discussed earlier in this paper. The leasing industry

effectively calculates the holding cost of the vehicle over the term. In simple terms this takes the purchase price, less residual value and applies a funding cost to the balance and divides it by the term.

This means that monthly leasing rentals are affected by the purchase price and residual value and this impact is of course passed to the bus operator.

This means that bus financing plays little part in the forward procurement of low carbon buses within the UK sector. Any subsidies and grants made available to generate procurement would be applicable to both leasing and outright purchase, as would associated risks which will be included in both leasing and purchase profiles.

The only area where financing may be of assistance to the forward procurement of low carbon buses would be in the area of battery and capacitor leasing for vehicle manufacturers. This would allow the manufacturer to recoup the cost of the batteries at point of sale and transfer the cost to revenue expenditure. However there will be a funding cost that will be built into the cost to the operator so the advantage of this is minimal.

6.8. Forward Commitment Implementation

A typical Forward Commitment strategy applied to procuring low carbon buses would comprise of three phases and which would take 3-4 years to complete. The typical phases in a forward commitment strategy being;

- Phase 1: Single vehicle demonstration of technology
- Phase 2: Small fleet trial of up to 10 near market ready vehicles
- Phase 3: Large volume procurement of market ready vehicles

Phase 1: Single vehicle demonstration
A single vehicle demonstration should last a minimum of 12 months. The technology is likely to be relatively less reliable and the component systems are unlikely to be optimised. As a result of their numbers, need to closely monitor and potential level of reliability these vehicles will need special support and the technology will not be put into mission critical operations and when used in front line operations they will only represent a fraction of the vehicles providing that service in order that the service delivery is not threatened. These vehicles are unlikely to have a significant useful life beyond the trial without significant modification.

Regime	Comment
Local Authority controlled	A local authority or PTE could provide the contractual framework to support single vehicle demonstration through a contracted service.

SQP	It would be too administratively cumbersome and in appropriate to set up a SQP specifically for a single vehicle demonstration. However a pre-existing SQP with well developed environmental KPIs could provide the framework of support required for a single vehicle demonstration.
Commercial route	A commercial route would be an inappropriate environment in which to try to support a single vehicle trial unless the bus operator and vehicle manufacturer were prepared to adsorb the costs and risks, which would be unlikely.

Phase 2: Small fleet trials

Small fleet trials are appropriate for near to market ready technology in which the main issue is shaking down the systems and proving reliability. These vehicles, by their nature and number, will be expected to perform front line operations and will be expected to have a long operational life beyond the trial, albeit potentially once having received a technology update or refurbishment.

Regime	Comment
Local Authority controlled	A local authority or PTE could provide the contractual framework to support a small fleet trial through a contracted service. However the term of the contract service would need to be of an appropriate length, between 5 years and the life of the bus.
SQP	As with single vehicle demonstrations it would be too administratively cumbersome and in appropriate to set up a SQP specifically for a small felt trial. However a pre-existing SQP with well developed environmental KPIs and funding directed to support environmental performance could provide the framework of support required for a small fleet trials.
Commercial route	A commercial route would be an inappropriate environment in which to try to support a small fleet trial unless the technology was very close to market ready and the bus subsidy was amended or supplemented in someway to reflect the total operation costs.

Phase 3: Large volume procurement

At this point the low carbon buses will have proved their operational performance, which will overall, have reached or exceeded the operational performance of normal buses, this will include environmental performance. This will trigger the Forward Commitment to procure a significant volume of low carbon buses,

overall this will be in the volume of hundreds of vehicles which are market ready. These vehicles will go into front line operations in which enhanced environmental performance, and in particular high fuel efficiency and low carbon emissions, are valued.

Regime	Comment
Local Authority controlled	A local authority or PTE could provide the framework required to value high energy efficiency and low carbon emissions through contracted services. However there may not be sufficient of these routes in the UK to absorb the volumes required outside London. Although they might provide a worthwhile addition to boost volume production in addition to London's TfL controlled routes.
SQP	SQP could provide the necessary framework to create a market for low carbon buses in the UK. They would require well developed environmental KPIs and either direct funding to reflect environmental performance or the bus subsidy would need to be amended to avoid bias towards high fuel consuming diesel buses.
Commercial route	The ability of a commercial route to provide a demand for low carbon buses would be critically dependent on the reliability of the technology and the manner in which the bus subsidy was provided in the future.

Implementing a Forward Commitment

The existing and planned regulatory regimes likely to be employed outside London in the future are able to support low carbon buses to varying degrees but none are universally appropriate to support a whole Forward Commitment process. Therefore to implement a Forward Commitment for low carbon buses in the UK outside of London will require utilising a number of contractual structures as set out in the table below.

Regime	Phase 1	Phase 2	Phase 3
Local Authority controlled	✓✓✓	✓✓	✓
SQP		✓	✓✓✓
Commercial route			✓

Local authority controlled services are highly suitable for supporting phase 1 and 2 of a Forward Commitment process, which involves demonstration and small fleet trials. However, local authority controlled services only account for 15% of bus services outside London and a relatively small volume of buses are procured

for these services each year. As a result, apart from supporting the volume of hybrid buses likely to be procured by London in the future, they won't provide a basis for fulfilling the third phase of a Forward Commitment, that of volume procurement.

SQP offer the best medium term opportunity to create the contractual conditions in which to support low carbon bus procurement through a Forward Commitment, however they are unlikely to be developed in time to be useful for the early stages of a Forward Commitment for low carbon buses. The development of SQPs should be done in a manner to value environmental performance and to create a demand for low carbon buses predominantly trialled and demonstrated on local authority controlled services.

Commercial routes are unlikely to play a significant role in implementing Forward Commitment for low carbon buses, or create an end market demand for them unless the bus subsidy is amended to provide appropriate support for these buses and reliability is proven to match diesel buses. However given a reduction in the premium capital cost of low carbon buses, coupled with reform of BSOG to make it supportive of Government's Climate Change policy could create the market conditions for low carbon buses to become competitive even on commercial routes.

6.9. Contractual arrangements

Underlying a Forward Commitment would be contracts creating the demand for the low carbon buses. These would be between PTEs and local transport authorities with bus operators and would include, as discussed above, contracts for local authority controlled routes, either through subsidy, contracted services, park and ride schemes, to quality partnerships and SQPs.

A Forward Commitment would consist of a consortium Agreement between the procurers and an agreement between that consortium and the suppliers. This agreement would set out a series of contracts, each invoked by the successful performance of the previous contract, covering the demonstration of a single prototype low carbon bus, the trial of a small fleet and finally, a call off contract for the supply of vehicles. This final call off contract would provide a framework for supply contracts between the bus operator and the supplier.

The contractual process for the individual contracts making up the Forward Commitment would remain the same but would require significant amounts of review to adapt to low carbon bus procurement. The areas of review would include:

- Development and creation of KPIs relating to low carbon buses
  - For bus manufacturer to operator

  - Operator to PTA/Local Authority
  - Operator to VOSA
- The formation of Strategic Quality Partnership systems with agreed terms and conditions and standards. The strategy must be designed to protect both the competitive measure of the route, the PTA and Local Authority and the operator.
- The formation of a buying consortium prepared to implement a Forward Commitment procurement process to gain economy of scale and volume discounts. This in turn provides volume expectations for manufacturers and sufficient ROI.
- The establishment of environmental standards across the UK that are achievable by manufacturers and operators.
- The re-launch of BSOG based upon energy/energy efficiency using existing mechanisms. The retention of the existing system will avoid confusion, retain the status quo and leaves the system easy to operate.

6.10. Conclusions

The implementation of a Forward Commitment strategy for low carbon buses is an achievable and practical option which could be implemented in the UK bus market outside London with the potential powers being granted to PTAs and local transport authorities. The key elements required relate to the ability of the PTA and local transport authorities to influence the bus market and the amendment of the bus subsidy, as set out in the previous section.

In the short term local authority controlled bus services can and will provide the best application in which to demonstrate and trial low carbon buses, as part of a low carbon bus forward commitment.

In order to deliver a sustainable market for low carbon buses will require intervention by PTAs and local authorities. Strategic Quality Partnerships appear to be a very important tool in establishing a demand for low carbon buses outside London in the medium to longer term and so securing a sustainable market.

A consistent approach to the development and implementation of SQPs will assist in creating a national market for low carbon buses. This is particularly the case with regard to environmental standards of performance.

The large five national bus operators are in effect procurement consortiums able to use purchasing power to gain favourable terms and cost reductions. Given the conditions for a national market for low carbon buses these groups will deliver cost reductions.

However in the short term in which a variety of organisations may be interested in purchasing these vehicles, including smaller bus operators and PTAs, there will

be a necessity to form a buying consortium to gain economy of scale and volume discounts.

Making a Forward Commitment is not a usual practice for bus operators and may present institutions with a challenge in feeling comfortable with the concept. However, we believe there is nothing to prevent a body specifying the future requirements and entering into a commitment to purchase products subject to appropriate clauses, such as proof of meeting performance criteria and representing value for money against criteria which include environmental factors.

A Forward Commitment once entered into would set out a series of contracts, each invoked by the successful performance of the previous contract. The final element would be a call off contract for the supply of vehicles which would provide a framework for supply contracts between the bus operator and the supplier.

From a contractual point of view the existing contractual practices would remain the same although they would have to be amended in a number of ways in order to deliver a low carbon bus forward commitment, not least to reflect KPIs appropriate for the demonstration and trial of low carbon buses.

Recommendations

It is recommended that a strategy for LowCVP in taking forward a low carbon bus initiative should comprise the following elements:

1. The development of a Strategic Quality Partnership framework that could be applied around the UK

2. Develop a set of KPIs and standards around the environmental performance of low carbon buses

3. Develop a minimum level of KPIs applicable to the support, maintenance and aftermarket support of buses and their technologies designed to provide a framework for manufacturers and operators

4. Work with PTEG and CPT to promote greater understanding of contractual processes required in implementing a Forward Commitment amongst local transport authorities and bus operators.

7. Financial Viability

7.1. Introduction

The objective of this part of the feasibility study was to consider the financial viability of low carbon buses and therefore to understand the level of funding support a Forward Commitment of low carbon buses would require. The potential sources of this support are then considered.

7.2. Financial Viability of Low Carbon Buses

The LowCVP has done much work in resent years on the viability of low carbon buses informed by input from it's members and studies by Sciotech, the Confederation for Passenger Transport and others. This feasibility study has benefited from this work. Consequently this study has avoided repeating this work but has sought stakeholder input to build a view on the feasibility of low carbon buses at two distinct points in the innovation process, that of demonstration and series production.

Section 8 reviews the variety of technologies which have the potential to reduce Green House Gas (GHG) emissions on a well-to-wheel (WTW) basis, reporting the extent of the carbon reductions which can be expected and at what cost. The conclusion drawn is that there are two groups of technologies, the first which have the potential to deliver in excess of:

- 40% GHG reduction on a WTW basis at medium to high comparative cost
- 20% GHG reduction on a WTW basis at low to medium comparative cost

This is compared to a baseline of Euro 3 bus WTW GHG emissions. While these categories cover a range of different technologies for ease of example the first category is assumed to represent hybrid buses, while the second the combination of low loss transmission, regenerative braking and stop-start technology.

The financial viability in demonstration and series production are considered below against the current regulatory and fiscal regimes. The potential impact of the BSOG reform in the short run, as set out in the DfT consultation started in March 2008, is also assessed. The detailed assumptions are shown in Appendix 5.

Demonstration Low Carbon Buses

During this part of the innovation process technologies typically have yet to be optimised in terms of integration or manufacturer and are consequently less reliable, have higher maintenance costs and capital costs.

Technologies delivering a 40% GHG reduction

The significant advantage of these technologies is that they offer significant reductions in fuel consumption, however this advantage is reduced by the current form of the BSOG, which is based on fuel duty rebate.

The potential operating cost advantage is further reduced by typically higher maintenance costs and poor reliability.

The capital cost of these vehicles is considerably higher than series production diesel buses, while this can be partially reduced through a Forward Commitment by recovering R&D costs over a larger volume of vehicles, the underlying technology costs are also high.

As a consequence these technologies at the demonstration phase would certainly not be commercially competitive with series production diesel buses. Over an assumed 15 year life the total cost of operating these vehicles will be of the order of 27% more expensive.

Impact of BSOG Reform

Increasing the fuel duty rebate to 100% would not be sufficient to allow these technologies to compete on a cost basis with series production diesel buses. Total life cost premium over diesel would reduce from 27% to 22%.

However, a flat rate bus subsidy of 21 p/km would be sufficient to make these technologies competitive over an assumed life of 15 years. This however would be too long and too uncertain to form the basis for a commercial decision.

Technologies delivering a 20% GHG reduction

These technologies offer a reduction in fuel consumption, but not as great as those technologies offer a 40% reduction in GHG emissions. Again the fuel consumption benefits compared to series production diesel buses is reduced by the current form of the BSOG, which is based on fuel duty rebate.

Again potential operating cost advantage over series production diesel buses is further reduced by typically higher maintenance costs and poor reliability.

The capital cost of these vehicles is higher than series production diesel buses, potentially 25% higher. However there is potential to reduce this through a Forward Commitment by recovering R&D costs over a larger volume of vehicles, as the underlying technology costs may not be significantly greater than existing transmissions in diesel buses.

As a consequence these technologies even at the demonstration phase could close to being cost competitive with series production diesel buses over the assumed 15 year life.

Impact of BSOG Reform
Increasing the fuel duty rebate to 100% would help ensure their cost competitiveness over the total life time of these buses. However, a flat rate bus subsidy of 18 p/km would give these technologies a total life costs advantage of 10% over series production diesel buses. This however may still not be sufficient to form the basis for a commercial decision in its own right.

Series Production Low Carbon Buses

Technologies delivering a 40% GHG reduction
Once in series production these technologies would continue to have a higher capital cost due to their higher technology cost, however this would be expected to be considerably reduced compared to demonstration vehicles.

Maintenance costs would continue to be significantly higher than current series production diesel buses, but this cost would be outweighed by the fuel consumption advantage. At this stage reliability is assumed to be equivalent to current buses.

Given the current form of BSOG these technologies, over a 15 year life, would still be significantly more expensive than normal diesel buses, approximately 12%, and so would not be cost competitive.

Impact of BSOG Reform
Increasing the fuel duty rebate to 100% would not be sufficient to allow these technologies to compete on a cost basis although the cost premium would be halved to approximately 7%.

A flat rate bus subsidy of 18 p/km would be sufficient to make these technologies competitive over an assumed life of 15 years, while a flat rate subsidy of 25 p/km would provide a significant cost advantage of some 24% over the vehicles life. This would allow these buses to provide a commercial return over a 6 year period.

Technologies delivering a 20% GHG reduction
In series production these technologies are cost competitive with current diesel buses and will breakeven in less than 12 years.

Impact of BSOG Reform
Increasing the fuel duty rebate to 100% would reduce the breakeven period to 6 years. However, a flat rate bus subsidy of 18 p/km would give these technologies a total life costs advantage of 15% over series production diesel buses and reduce the breakeven point to less than 4 years.

7.3. Marginal Cost of a Low Carbon Bus Forward Commitment

The marginal cost of undertaking a Forward Commitment was estimated by comparing the cost of procuring low carbon buses capable of achieving a 40% reduction in GHG WTW (Tier 1) and a 20% reduction in GHG WTW (Tier 2) with the cost of purchasing normal diesel buses.

The example used is of a Forward Commitment process comprising of;

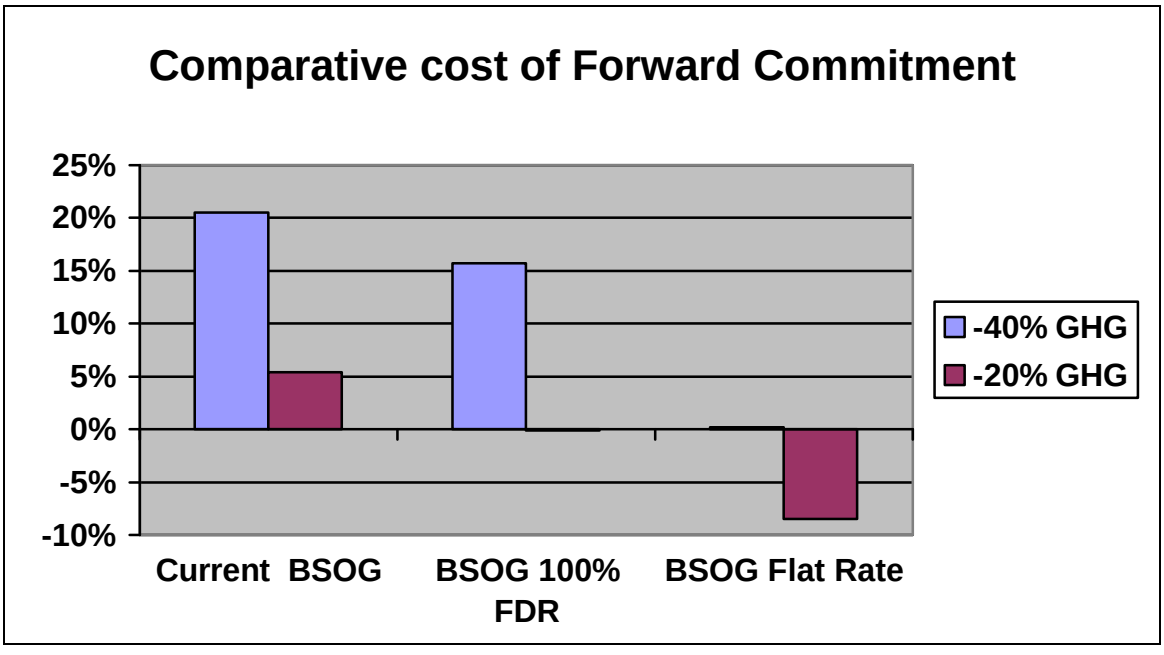
- 5 separate single vehicle demonstrations
- 2 small fleet trials for routes requiring 9 buses
- Single procurement of 500 low carbon buses

It is assumed these are purchased for a single contract lasting 7 years and that depreciation is straight line over this period for all types of buses. This Forward Commitment would replace the procurement of 523 normal diesel buses.

The results are shown in the chart below under three scenarios;

1. BSOG remains the same.
2. BSOG is amended to provide a 100% Fuel Duty Rebate for low carbon buses.
3. BSOG is amended to a flat rate for low carbon buses of 18 p/km.

This marginal cost would need to be funded in order to undertake the Forward Commitment.



The low carbon bus technologies capable of reduction GHG by 20% on a WTW basis are within 5% of the cost of procuring normal diesel buses even under the current form of bus subsidy, and could offer a cost saving if a flat rate p/km form of BSOG was introduced which was slightly higher than parity with normal diesel buses.

The technologies capable of reducing GHG emissions by 40% or more, require a significant level of funding, between 15% and 27% more than purchasing the equivalent number of normal diesel buses. This would be of the order of up to £20 million for a full Forward Commitment as outlined in the example.

For both Tier 1 and Tier 2 low carbon bus technologies, the vehicle has a higher capital cost which is set against lower operating costs compared to a normal diesel bus. The BSOG, in its current form or amended as proposed in the immediate short term in the DfT consultation issued in March 2008, subsidises only the operating costs. It would be more effective to subsidise the full cost, both capital and operating costs, of public service vehicles.

7.4. Sources of Funding

There a number of sources of funding which might be secured to finance a low carbon bus procurement, these are:

- BSOG amended in the short term to either a 100% fuel duty rebate of a flat rate figure for low carbon buses.
- The Low Carbon Vehicle Procurement programme.
- Equivalent level of funding to BSOG distributed to SQP areas via local transport authorities.
- PTE and local authority capital budgets.

The examples used above show that BSOG reform will potentially be an important source of funding for a low carbon bus Forward Commitment. However even if amended, BSOG is an ineffective means of ensuring public funds support Government policy objectives in the area of climate change and the environment. This is due to the level of subsidy required to make a low carbon bus cost competitive during its first contract, so influencing the investment decision, means that the later part of the buses life is subsidised excessively. Focus should be given to subsidising the whole cost of low carbon buses.

The Low Carbon Vehicle Procurement programme has the potential to provide very targeted and effective support for the procurement of low carbon vehicles. To date this programme, still only in its first year of operation, has been directed at light commercial vehicles. The application of the programme to low carbon buses in conjunction with an amendment of the BSOG would provide a powerful means of providing up front finance. Despite the programme being restricted to public sector bodies, this programme could provide a useful source of funding to support single vehicle trials and small fleet trials.

In the medium term, funding routed to support SQPs via local transport authorities and PTEs along with funding from local transport authority own budgets are important potential sources of funding. The issues involved in securing funds for a low carbon bus Forward Commitment are explored in Section 5.

7.5. Conclusions and Recommendations

Technologies capable of a 40% or more reduction in GHG are not cost competitive under the existing fiscal and regulatory regime. In particular the form of BSOG is biased against the technologies which can deliver large GHG reductions.

Those technologies which deliver a 20% reduction in GHG have the potential to be cost competitive even under the current regulatory and fiscal regime.

The short term amendments proposed in the DfT consultation on the bus subsidy with regard to BSOG are important and have the potential to improve the viability of low carbon bus technologies.

However, BSOG while it remains focus on subsidising operating costs will be an inefficient means of providing support.

The Low Carbon Vehicle Procurement programme, despite its current focus on public sector organisations, could provide very important support alongside amendments to BSOG.

In the medium to long term if subsidises persist they should be developed to cover both operating and capital costs.

Recommendations

1. Continue to lobby for the reform of BSOG and in particular for a flat rate alternative to BSOG for low carbon buses.

2. Discussions with DfT to promote the case for low carbon buses as part of the Low Carbon Vehicle Procurement Programme.

8. Low Carbon Bus Specification

8.1. Introduction

The objectives of this part of the feasibility study were:

- To develop a draft specification of a low carbon bus appropriate for procurement purposes
    - The specification to be "technology neutral"
    - The specification to be shared with Transport for London and the TRUS consortium and COMPRO project, which are looking at the potential for a common European specification
- Seek supplier feedback on the draft specification and the volumes required to establish economies of scale

8.2. Draft Specification for Low Carbon Bus

Below is a summary for the proposed draft specification for a low carbon bus. This is the result of the discussions with stakeholders based upon the review of technologies, costs, carbon dioxide emission reduction and performance requirements. The result presents two proposals for CO2 reduction based upon what would be achievable with and without reform of the bus subsidy. How the specification was derived is presented in detail in the section below.

Parameter	Requirement
Tier 1 greenhouse gas carbon-dioxide equivalent performance	- 40% (minimum) c.f. Euro 3 equivalent bus on MLTB drive cycle See Table 1 for targets
Tier 2 greenhouse gas carbon-dioxide equivalent performance	- 20% (minimum) c.f. Euro 3 equivalent bus on MLTB drive cycle See Table 1 for targets
Gradeability (with maximum load)	10%
Range / Endurance	250 miles / 400 km
Range (zero emissions) - optional	4 miles / 6.4 km
Drive-by noise performance (exterior)	80 dB(A) as per EU Directive
Drive-by noise performance (interior)	As per current TfL requirements (data to be supplied)
Air quality emissions	Reductions to be obtained on the

	MLTB drive cycle See Table 2 for targets
Exhaust position (if appropriate)	Non near-side
Refuelling	Once a day
Construction & Use	EU Bus & Coach Directive 2001/ 85
Life cycle assessment (LCA)	ISO 14000 series

8.3. Methodology

The proposed specification for a low carbon bus was developed from an assessment of current practice in bus procurement, analysis of previous procurements of new technologies applied to the buses, and a wide stakeholder review within the Low Carbon Vehicle Partnership's members and the wider stakeholders involved in the UK bus market. Specifically the follow process was followed in developing the specification:

- Research basis for specification: Detailed interviews and assessment of the procurement practices and case studies for trials of new bus technology were undertaken of both Transport for London and MerseyTravel.
- Stakeholder review amongst LowCVP members: Initial findings were presented to the LowCVP's Bus Working Group in November 2007 and January 2008.
- Workshop to develop low carbon bus specification concept: The draft proposals for the specification were presented to a wider group of stakeholder in the UK bus market including: bus operators, local authorities and operators.

8.4. Stakeholder engagement

Preliminary data was presented to the LowCVP Bus Working Group meeting on 15 November 2007.

A workshop was held at the DfT premises on 18 January 2008. Attendees first met in a common plenary session and then split into Policy and Specification break-out groups.

Prior to the workshop a preliminary specification had been drawn up and circulated to the attendees to form a basis for discussion.

Companies and organisations represented in the Specification break-out group were as follows:

- Alexander Dennis Ltd. (ADL)
- Arriva
- Cummins Westport
- Merseytravel
- Sciotech (also representing the TRUS programme)
- TfL-London Bus Services Limited (TfL-LBSL)
- Traction Technology Limited (TTL)
- Transdev
- Volvo

Attendees were invited to correspond by e-mail should there be any revisions or clarifications required following the workshop.

The results from the workshop were presented to the subsequent LowCVP Bus Working Group meeting on 23 January 2008 where, in addition to those companies and organisations represented at the workshop were the following:

- Capoco Design
- Confederation for Passenger Transport (CPT)
- Ove Arup
- Technology Strategy Board (TSB)
- Torotrak

8.5. Technologies

There are many possible low carbon technologies that could be supplied to the bus market. The following technologies were assessed in drawing up the low carbon bus specification:

- Series hybrid
- Parallel hybrid
- H2ICE
- H2FC
- Novel gearbox
- Stop-start
- Regenerative braking
- Renewable fuel (e.g. biodiesel, bioethanol, biogas and hydrogen)
- Battery-electric
- Catenary
- Combinations of the above

Additionally, there are several hybrid energy storage media possibilities including the following:

- Batteries (several technologies available)
- Ultra capacitors
- Flywheel
- Hydraulic
- Pneumatic

In the UK the following bus low carbon technologies have been recently trialled or are in service:

- H2FC
- Battery-electric
- Series hybrid battery energy storage
- Micro-turbine
- Diesel

In the UK the following designs are in development or are likely to be introduced or re-introduced:

- Parallel hybrid
- H2ICE
- H2FC
- Novel reduced losses gearbox
- Flywheel energy storage

In the USA low carbon buses have made a large impact under very different fiscal arrangements to those of the UK with national, state and city government subsidies[9] - the main technologies are as follows:

- Series diesel-electric hybrid
- Parallel diesel-electric hybrid
- Methane

There were over 1300 diesel-electric hybrids by the end of 2006 compared to only 18 in the UK.

[9] "New York City Transit (NYCT) Hybrid (125 order) and CNG Transit Bus: Final Evaluation Results", R Barnitt (NREL) and K Chandler (Battelle), NREL/TP-540-40125 November 2006
"King County Metro Transit Hybrid Articulated Buses: Final Evaluation Results", K Chandler (Battelle) and K Walkowicz (NREL), NREL/TP-540-40585 December 2006
"Case Study: Ebus Hybrid Electric Buses and Trolleys", R Barnitt (NREL), NREL/TP-540-38749 July 2006

Relative costs
The following table was shown at the Workshop to give samples of different technologies, their GHG performance and relative costs for both vehicle premium and, if appropriate, infrastructure.

Table 2: Relative technology costs

Technology	Technology Relative cost	Infrastructure Relative cost	GHG Reduction
Catenary	Medium	Very high	30% - 100%
H2FC	High	High	Up to 100%
Hybrid	High	None	30% - 40%
H2ICE	Medium	High	Up to 100%
Biogas	Medium	Medium high	75% - 243%
Battery-electric	Medium	Medium	30% - 100%
Stop-Start	Low	None	5% - 25%
Regenerative braking	Low	None	5% - 30%
Low loss transmission	None	None	10% - 20%

8.6. Effect of Bus Service Operators' Grant

Some technologies are much more attractive if BSOG is reformed, for example:

- Fuel cost saving is much less with BSOG qualifying operations with 80% of fuel duty rebated (staged routes)
- Break-even point not reached in an acceptable period of time on some technologies such as diesel-electric hybrid
- For any fuel saving technology the Government actually save rebating considerable fuel duty

At the LowCVP Bus Working Group meeting on 18 January 2008 the DfT presented an overview of a consultation process to be undertaken on BSOG. This will run from March 2008 for 12 weeks.

Two tier approach
In the light of the effect of BSOG and the fact that there may be cost-effective technologies that meet a lesser GHG reduction, the workshop attendees were asked the following:

- Should there be a two tier specification?

A possible approach could be as follows:

- Tier 1: X% GHG reduction compared to Euro 3 baseline, well-to-wheels
- Tier 2: 0.5X% GHG reduction compared to Euro 3 baseline, well-to-wheels

The workshop attendees debated the definition of the baseline and whether to be on a well-to-wheels or tank-to-wheels basis. Clearly, to be technology neutral, well-to-wheels had to be the case. As the LowCVP Bus Working Group already had a well defined Euro 3 baseline it was agreed to remain with that. Note that TfL are preparing a Euro 4 baseline for their specifications on a tank-to-wheel basis.

It was also agreed that the two tier approach should be carried forward due to the uncertainty regarding BSOG and the length of time that may be necessary should a reform be undertaken; for example, EU State Aid negotiations may take upwards of 18 months. Note that BSOG pre-dates the UK entry to the EU and is, therefore, not subject to these regulations.

The following was therefore agreed:

- Tier 1: 40% GHG reduction compared to WTW Euro 3 baseline
- Tier 2: 20% GHG reduction compared to WTW Euro 3 baseline
- Baseline defined in LowCVP Bus Working Group document BWG-P-05-04 (February 2005)

See Table B of the Specification (Appendix 4) for tabulated targets versus passenger capacity.

GHG baseline

The original bus baseline was calculated against a characteristic curve derived for diesel Euro 3 types as tested on the MLTB cycle (see Appendix 2) using TTW CO2 measurements adjusted for the additional WTT component. For this Specification to allow for all possible technologies, the same results will now represent total GHG CO2 equivalent emissions. The original target line was expressed by the following equation (30% GHG reduction):

GHG CO2 equivalent (well-to-wheel) g/km =

(7.25 x total number of passengers) + 480

See LowCVP Bus Working Group document BWG-P-05-04 (February 2005). See also Appendix 3 for original curve fit.

At the workshop the issue about route specific nature of hybrids' fuel consumption performance was raised whereby the MLTB cycle was deemed not necessarily representative. For the forward procurement process there should be an allowance to undertake fine tuning during initial trials to optimise fuel consumption on the target route.

Air quality emissions

At the workshop the following air quality emissions requirement was debated - should target air quality emissions be set and if so at what level?

- Euro 4?
- Euro 5?
- EEV?

An issue that was noted was that given that the basis for emissions testing was agreed to be whole vehicle tests on the MLTB cycle, then the question was raised how could equivalence to heavy duty emissions legislation be determined as this is applied to an engine on test bed?

After discussion it was decided that an EEV level of emissions should be the basis of the target.

Note that the basis for emissions testing has been whole vehicle tests on the MLTB cycle and an attempt was made from existing Euro 3 data to define a NOx and Pm target line versus passenger capacity. This was then factored by the ratio of EEV to Euro 3 legislation. The results are shown in Table C of the Specification (Appendix 4).

A zero emission mode was discussed and it was agreed to have an optional requirement of 4 miles range. This reflects the fact that some authorities may require this feature but that not all technologies are able to achieve ZEV performance.

Note that TfL have no plans for a zero emissions zone for London bus operations.

Table 3: European Heavy Duty engines emissions legislation

Legislation	CO	NMHC	CH4	NOx	Pm
	g/kWh	g/kWh	g/kWh	g/kWh	g/kWh
Euro 3	5.45	0.78	1.6	5.0	0.16
Euro 4	4.0	0.55	1.1	3.5	0.03
Euro 5	4.0	0.55	1.1	2.0	0.03
EEV	3.0	0.40	0.65	2.0	0.02

Noise

The workshop attendees agreed that exterior noise should follow current EU legislation of 80 dB(A) but that interior noise should follow the TfL-London Buses requirements (to be supplied by TfL-London Buses).

Vehicle specifics
The workshop attendees agreed to use the whole vehicle approval EU Bus & Coach directive 2001 / 85 to cover the following:

- Performance
- Access
- Disability requirements
- EMC
- H & S
- Etc.

Life cycle assessment (LCA)
At the suggestion of the workshop attendees it was agreed to add the requirement for full LCA documentation of the vehicle and systems' components. ISO 14000 series standards apply.

Harmonisation of specifications
Despite co-operation from TfL, TRUS and COMPRO in terms of sharing information and ideas on developing a low carbon bus specification, it became apparent during the project that a harmonisation of the specification around TfL, TRUS and COMPRO programmes may be problematical.

The TfL approach is for reduced GHG tailpipe emissions. This will be achieved by hybridisation and / or use of hydrogen as an energy vector. TfL has on order the following vehicles:

- 5 hydrogen internal combustion engines types (H2ICE)
- 5 hydrogen fuel cell types (H2FC)
- 50 diesel-electric hybrids of differing configurations

Consequently TfL are developing specifications for specific vehicle types rather than a technology neutral approach. TfL are considering a radical approach regarding GHG targets (based on tank-to-wheel) whereby, rather than against a passenger capacity, it will be on a per vehicle type:

- Single decker
- Double decker
- Articulated

Clever design may accommodate more passengers within the envelope accordingly without incurring a baseline GHG penalty.

The TRUS programme has at its heart a driveline sub-system consisting of a battery pack plus electric motor. This enables a modular approach to be taken for three types of bus:

- Battery-electric
- Hybrid
- Catenary

The COMPRO project has yet to develop a specification although they are interested in procuring two broad types of low carbon bus technologies, these being gas and hybrid technologies.

As far as possible the specification proposed has been designed to be broad enough to incorporate the aspects of both approaches to developing a specification. To this end all of these technologies are accommodated within the technology neutral specification described here.

Volumes
Significant cost break points are expected to be achieved with around 1000 units. This was based upon stakeholder input and an analysis of the economics of bus drivelines undertaken for DfT by Sciotech.

The ability of TfL or the UK as a whole to influence the European bus production is questionable given that new bus sales in the UK of buses greater than 8.5 tonnes range between 2000 and 3000 vehicles per annum. As a consequence it was recommended that the UK should seek collaboration with stakeholders in the European bus market with regard to developing a common specification.

Hybrid test protocol
It was noted that TfL were reviewing the hybrid test protocol as a result of inconsistencies in results reported using the MLTB test cycle. This is thought to be due to the strategies being employed by hybrid bus manufacturers. The findings will be reported to the LowCVP Bus Working Group in due course.

Fleet trials
It is envisaged that there will be 3 acceptance phases within the Forward Commitment process and covered by the contract – satisfactory performance to be achieved at each phase before taking the programme to the next level. The likely structure is as follows:

- Phase 1 – individual demonstration vehicles
    - Bus to achieve near to target performance on MLTB
    - Some refinement of calibration / set-up during phase
- Phase 2 – small fleet trials of the order of 10 buses on one route
    - Buses to achieve close to target performance in service

    - Further refinement of calibration / set-up and vehicle to vehicle performance variation assessment
- Phase 3 – large scale procurement of circa 500 buses
    - Buses to exceed target performance in service

8.7. Conclusions

- There was sufficient OEM / Operator / PTA interest shown in the workshop exercise to indicate that a forward commitment programme for low carbon bus procurement may go forward
- Cost-effectiveness is a major issue; e.g. with the present BSOG structure there is no commercial incentive to operate hybrids in the UK. However, this is likely to change during 2008.
- European emission test cycles were seen as inappropriate for defining fuel consumption and GHG emission reduction targets. A real world test cycle is required for this and the MLTB was proposed. It was recognised there were other real world test cycles which could be used which as an equivalent.
- A two tier GHG target system was agreed; with 40% and 20% GHG reductions as tested on the MLTB drive cycle.
- Final pass-off performance on GHG / fuel consumption will be route specific and based upon in service fuel consumption.
- It will be dependent on the future structure of BSOG whether Tier 1 or Tier 2 should be used for a forward commitment process; there may even be scope for them to run in parallel.
- For significant cost reductions component levels need to run at 1000 systems p.a.
- UK sales of >8.5 tonne buses has recently varied between 2400 and 3000 p.a.
- Pooling of component purchase and / or pan-European collaboration will be required to reduce unit costs for some of the technologies.

Recommendations

1. PTAs, PTEG and local transport authorities should liaise with TfL to gain from their experience of specifying and procuring hybrid buses in London.

2. Seek to promote a common low carbon bus specification with European partners.

9. Conclusions

Stakeholder Interest

There has been interest in introducing low carbon buses in the UK for some time. This is testified to by the number of trials and demonstrations of buses using alternative fuels or power systems, with the potential to be low carbon buses, conducted across the UK during the last two decades. These trials have typically been collaborative projects involving local authorities, manufacturers and bus operators and have focused on technology proving, in additional to assessing operational performance, costs and other technical issues. The funding for these projects has been provided from European and national programmes to support R, D&D projects. To date none of them have involved large-scale dedicated fleets of low carbon buses although the trials of hybrid buses in London will in total involve between 60-70 buses once complete.

In 2004 the Energy Saving Trust proposed a grant fund to support the introduction of low carbon buses, which it along with DfT developed and sought State Aid approval for from the European Commission. Plans for the programme were dropped in 2006 however, the programme had been widely consulted upon and was strongly supported by all the bus manufacturers active in the UK, all of whom have development programmes in place for low carbon buses.

Although it was not feasible to determine in a quantifiable manner the level of interest in low carbon buses and the Forward Commitment strategy to procure innovation in this market, the following broad conclusions were drawn from discussions with stakeholders.

There was significant support from the major bus manufacturers and system suppliers active in the UK for developing a wider market for low carbon buses beyond London. There was no principle concern with the Forward Commitment strategy given the understanding that the low carbon bus specification set out targets for final performance rather than definitive requirements.

PTEG were seen as a critical stakeholder group in securing a market for low carbon buses outside London. During the project it became apparent that there was considerable interest amongst this group in introducing these vehicles and that PTEG was conducting a review on behalf of its members into the type of vehicles most appropriate to deliver the environmental performance they require. This study is on going at the time of preparing this report.

There was interest amongst bus operators, however given the commercial environment and fiscal regime there was concern over the viability of low carbon buses. In addition there was particular concern over reliability of buses during trials and demonstrations.

In conclusion it was felt there was sufficient interest shown by bus manufacturers, operators and PTAs during the exercise to indicate that a forward commitment programme for low carbon bus procurement might be successful, although this should be investigated more thoroughly.

Policy Drivers

Local transport authorities are constrained by current legislation and there are few direct opportunities for them to specify low carbon buses in their areas. Nevertheless, the broad policy drivers coming from Government are to encourage and stimulate national and local actions to reduce greenhouse gas emissions, and the introduction of low carbon vehicles forms one important part of this strategy. These drivers can be seen in the broad policy initiatives contained in new legislation such as the Climate Change Bill, and in the recent strategy and guidance documents such as the Low Carbon Transport Innovation Strategy and the Energy Measures Report.

Moreover, there is a new enabling environment for local transport authorities, including PTAs, with the forthcoming legislation in the Local Transport Bill. Once enacted, this should give more flexibility for introducing low carbon buses. In particular the revival of powers for PTAs to lease buses to operators that are providing services under a subsidised service contract or a quality contracts scheme could be a focus for a PTA to buy and then lease low carbon buses in appropriate situations.

Reform of BSOG also offers an opportunity for stimulating the demand for low carbon buses. In the current consultation, DfT is proposing options for reform include improved financial incentives for operators to invest in new technology, particularly low carbon buses.

It can be seen that the powers granted to PTA's and to a lesser extent local transport authorities would make low carbon bus procurement outside London possible on subsidised routes, contracted routes, in-house services and through Quality Partnerships and Contracts.

Hence the main opportunities for PTA and local transport authority involvement could include:

- Subsidised routes which are socially necessary but not economic;
- Park and Ride services;
- Strategic Quality Partnerships between PTA, Local Authorities and operators
- In-house transport such as school buses and social services;
- Quality partnerships/quality contracts, supported by BSOG funds.

The potential pitfalls in this approach include:

- State Aid restrictions on the use of public funds to support commercial operators;
- Whether local transport authorities and bus operators which are entering into, or are participating in, a quality partnership scheme or other bus partnership agreement, comply with competition law;
- The application by the District Auditor of best value criteria in judging local authority expenditure.

Care will be needed to make use of the new powers in the Local Transport Bill (once enacted) so that any proposals are fully costed, with evidence that they can be funded, and that they are in the public interest and represent good value for money.

Contractual Structures

The implementation of a Forward Commitment strategy for low carbon buses is an achievable and practical option which could be implemented in the UK bus market outside London with the potential powers being granted to PTAs and local transport authorities. The key elements required relate to the ability of the PTA and local transport authorities to influence the bus market and the amendment of the bus subsidy, as set out in the previous section.

In the short term local authority controlled bus services can and will provide the best application in which to demonstrate and trial low carbon buses, as part of a low carbon bus forward commitment.

In order to deliver a sustainable market for low carbon buses will require intervention by PTAs and local authorities. Strategic Quality Partnerships appear to be a very important tool in establishing a demand for low carbon buses outside London in the medium to longer term and so securing a sustainable market.

A consistent approach to the development and implementation of SQPs will assist in creating a national market for low carbon buses. This is particularly the case with regard to environmental standards of performance.

The large five national bus operators are in effect procurement consortiums able to use purchasing power to gain favourable terms and cost reductions. Given the conditions for a national market for low carbon buses these groups will deliver cost reductions.

However in the short term in which a variety of organisations may be interested in purchasing these vehicles, including smaller bus operators and PTAs, there will be a necessity to form a buying consortium to gain economy of scale and volume discounts.

Making a Forward Commitment is not a usual practice for bus operators and may present institutions with a challenge in feeling comfortable with the concept.

However, we believe there is nothing to prevent a body specifying the future requirements and entering into a commitment to purchase products subject to appropriate clauses, such as proof of meeting performance criteria and representing value for money against criteria which include environmental factors.

A Forward Commitment once entered into would set out a series of contracts, each invoked by the successful performance of the previous contract. The final element would be a call off contract for the supply of vehicles which would provide a framework for supply contracts between the bus operator and the supplier.

From a contractual point of view the existing contractual practices would remain the same although they would have to be amended in a number of ways in order to deliver a low carbon bus forward commitment, not least to reflect KPIs appropriate for the demonstration and trial of low carbon buses.

Commercial Viability

Currently cost-effectiveness is a major issue for low carbon buses. Under the current regulatory and fiscal regime there is no commercial incentive to operate low carbon buses, and only on local authority controlled routes is there the potential to take into account the environmental benefit of low carbon buses. As a consequence low carbon buses can be viable on local authority controlled routes, which include all London's bus services, controlled by TfL and 15% of all services outside of London.

However, the proposed powers set out of the Local Transport Bill and the proposed amendments to the bus subsidy set out in the bus subsidy consultation offer the potential for a longer term market to be created for low carbon buses in the UK. If these amends aren't introduced then the more innovative and beneficial technologies are unlikely to be commercially viable in the UK.

Draft Low Carbon Bus Specification

One of the objectives of the project was to develop a draft specification for a low carbon bus appropriate for procurement purposes which is technology neutral and which could be shared with other bodies interested in procuring low carbon buses, including Transport for London and the TRUS consortium and COMPRO project, which are looking at the potential for a common European specification.

With regard to carbon dioxide emissions, a two tier target was proposed to take account of the uncertainty with regard to the bus subsidy and regulatory framework. The first delivers a 40% GHG reduction. Technologies delivering this level of emissions reduction would only be viable if PTAs and local authorities are given grater powers to influence regional bus markets and bus subsidy is reformed. The second delivers a 20% GHG reduction compared to

current buses using nearer to market technologies. It was agreed that this should be based upon the MLTB drive cycle.

While the targets for the Forward Commitment process should be framed against clearly defined basis, the final target which triggers the purchase commitment will be based upon in service performance.

It will be dependent on the future structure of BSOG whether Tier 1 or Tier 2 should be used for a forward commitment process; there may even be scope for them to run in parallel

Based upon bus manufacturer and component supplier feedback, it is believed that in order to achieve significant cost reductions component production would need to be of the order of 1000 systems p.a.

The UK market for new buses over 8.5 tonnes is relatively small and is between 2,000 to 3,000 buses per annum. Consequently in order to achieve sufficient volume it will be advantageous to develop the specification for, and procurement of, in collaboration with European partners. This will assist in reducing unit costs for some of the technologies.

Recommendations
It is recommended that a strategy for the LowCVP in taking forward a low carbon bus initiative should comprise the following elements:

1. Undertake a telephone survey of PTAs and a representative sample of local transport authorities and bus operators in order to establish more clearly the extent of market demand for low carbon buses;

2. Liaison with TfL to gain from their experiences of specifying and procuring hybrid vehicles in London;

3. Discussions with the PTAs and PTEG, and leading local transport authorities, in order to develop the ideas from this feasibility study further, including the possibility of a non-London based approach to specifying and procuring low carbon buses;

4. Continue to press for reform of BSOG and in particular for a flat rate alternative to BSOG for low carbon buses in the short term;

5. The Include bus driver training, via an activity such as SAFED, in the development of a fleet procurement programme;

6. Seek to secure low carbon buses as part of the Low Carbon Vehicle Procurement Programme;

7. The development of a Strategic Quality Partnership framework that could be applied around the UK which incorporates encouragement for low carbon buses;

8. Develop a set of KPIs and standards around the environmental performance of low carbon buses for each stage in the Forward Commitment process;

9. Develop a minimum level of KPIs applicable to the support, maintenance and aftermarket support of buses and their technologies designed to provide a framework for manufacturers and operators

10. Develop a strategic partnership with PTEG and CPT to promote understanding of the procurement processes required to implement a Forward Commitment.

Appendix 1

Emissions Data

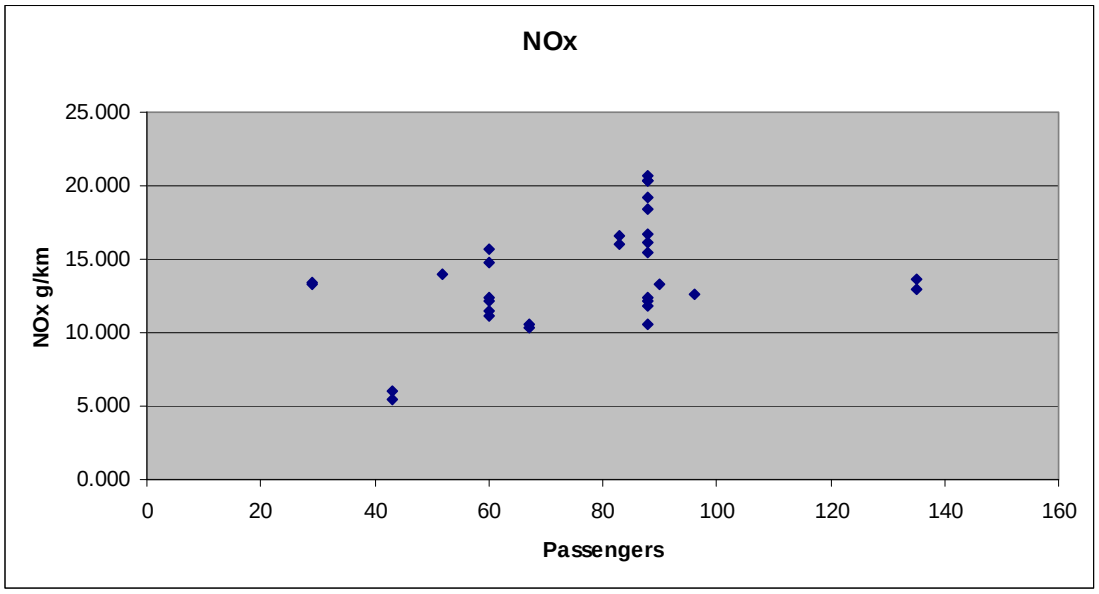
NOx calculations

Table 4: NOx Euro 3 buses with no NOx after treatment

Make	Model	Engine	Type	Passenger total	NOx (g/km)
Dennis	Dart	Cummins ISBe3	SD	60	15.674
Mercedes-Benz	Citaro 12m		SD	96	12.600
Dennis	Dart	Cummins ISBe3	SD	60	12.350
Dennis	Dart	Cummins ISBe3	SD	60	11.127
Dennis	Pointer Dart	Cummins ISBe3	SD	52	14.029
Optare	Solo	M-B OM904LA	SD	43	5.430
DAF	SB120	Cummins ISBe3	SD	90	13.267
Dennis	Trident	Cummins ISCe3	DD	88	16.099
Dennis	Trident	Cummins ISCe3 260 hp	DD	88	20.287
Dennis	Trident	Cummins ISCe3 225 hp	DD	88	19.213
Dennis	Trident	Cummins ISCe3	DD	88	15.474
Dennis	Trident	Cummins ISCe3 225 hp	DD	88	18.438
Volvo	B7TL		DD	88	12.130
Leyland	Olympian	Cummins	DD	83	16.060
Dennis	Trident	Cummins ISCe3	DD	88	20.392
Volvo	B7TL		DD	88	11.767
Dennis	Trident	Cummins ISCe3 225 hp	DD	88	20.733

Volvo	B7TL		DD	88	12.420
Scania		DSC902	DD	88	10.578
DAF	DB250		DD	88	16.695
Mercedes-Benz	Citaro G	OM906LLA	Artic	135	13.613
Mercedes-Benz	Citaro G	OM906LLA	Artic	135	12.984
Optare	Solo	M-B OM906	SD	43	6.020
Dennis	Dart	Cummins ISBe3	SD	60	11.490
Dennis	Dart	Cummins ISBe3	SD	60	12.170
Dennis	Dart	Cummins ISBe3	SD	60	14.730
Leyland	Olympian	IVECO	DD	83	16.610
Optare	Excell	Cummins ISBe3	SD	67	10.360
Optare	Excell	Cummins ISBe3	SD	67	10.570
Marshall	Midi Bus	Cummins ISBe3	SD	29	13.340
Marshall	Midi Bus	Cummins ISBe3	SD	29	13.440

Figure 1: NOx versus passenger numbers



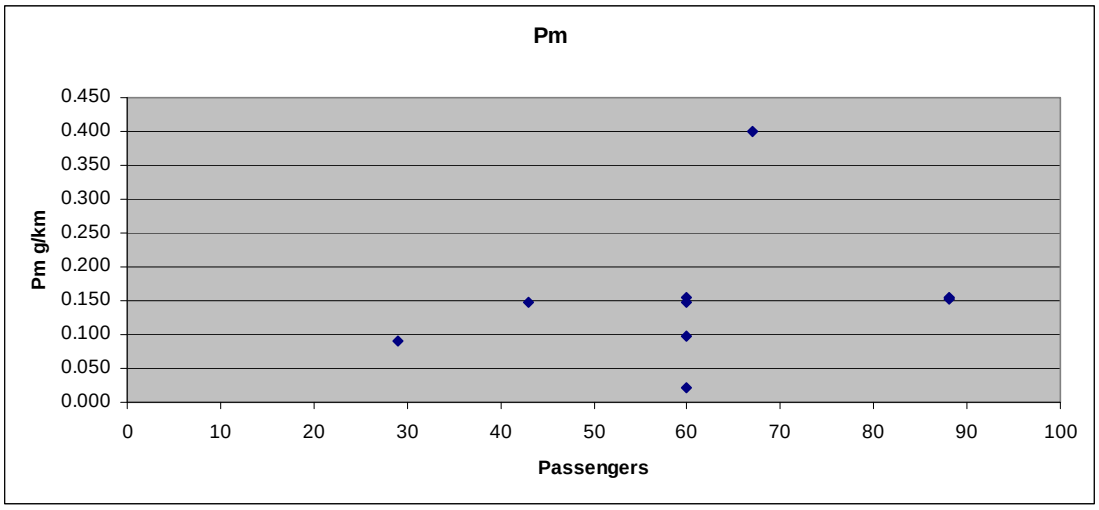
slope 0.054667
intercept 9.697988
r^2 0.380212
NOx (g/km) = (0.0547 x passengers) + 9.698

Particulates calculations

Table 5: Euro 3 buses with no Pm after treatment

Make	Model	Engine	Type	Passenger total	Pm (g/km)
Dennis	Dart	Cummins ISBe3	SD	60	0.148
Dennis	Trident	Cummins ISCe3 260 hp	DD	88	0.153
Dennis	Trident	Cummins ISCe3 225 hp	DD	88	0.154
Optare	Solo	M-B OM906	SD	43	0.148
Dennis	Dart	Cummins ISBe3	SD	60	0.021
Dennis	Dart	Cummins ISBe3	SD	60	0.097
Dennis	Dart	Cummins ISBe3	SD	60	0.154
Optare	Excell	Cummins ISBe3	SD	67	0.4
Marshall	Midi Bus	Cummins ISBe3	SD	29	0.09

Figure 2: Pm versus passenger numbers



slope	0.001342
intercept	0.068888
r^2	0.244346

Pm g/km = (0.001342 x passengers) + 0.069

Appendix 2

Millbrook London Transport Bus (MLTB) Drive Cycle

Figure 3: MLTB Phase 1 (Outer London)

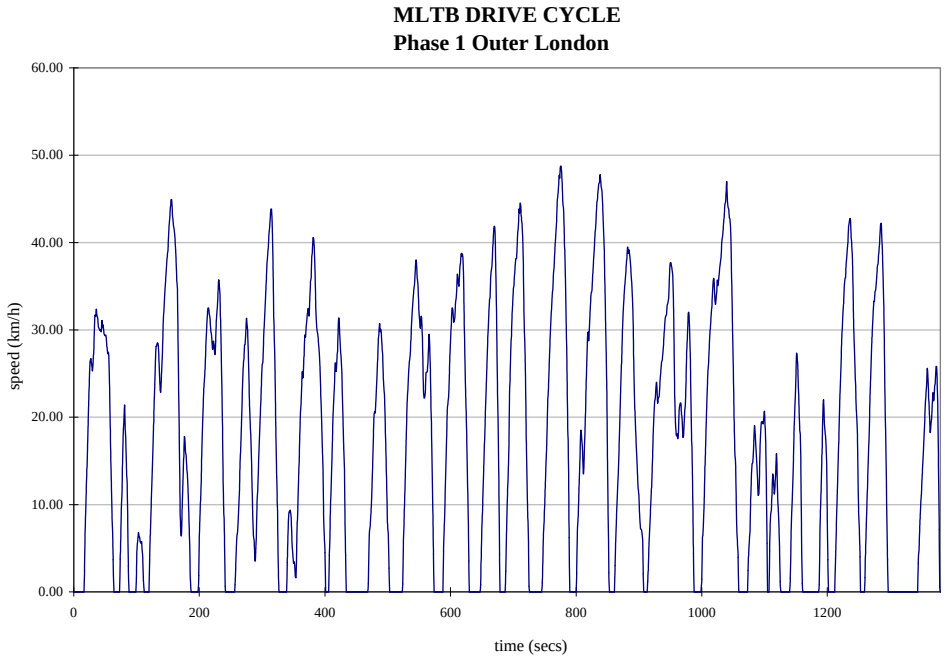
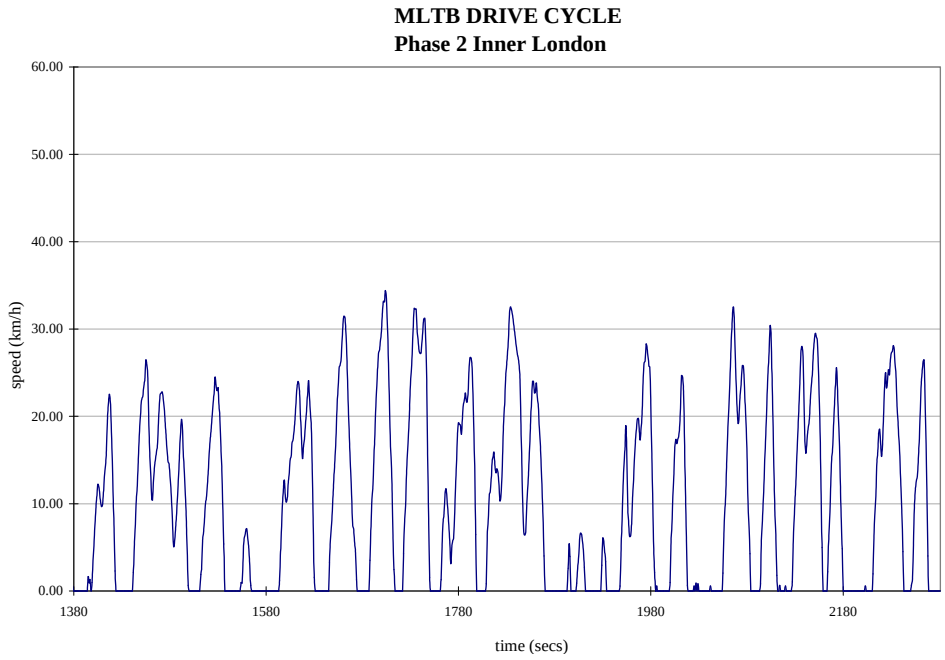


Figure 4: MLTB Phase 1 (Inner London)



Appendix 3

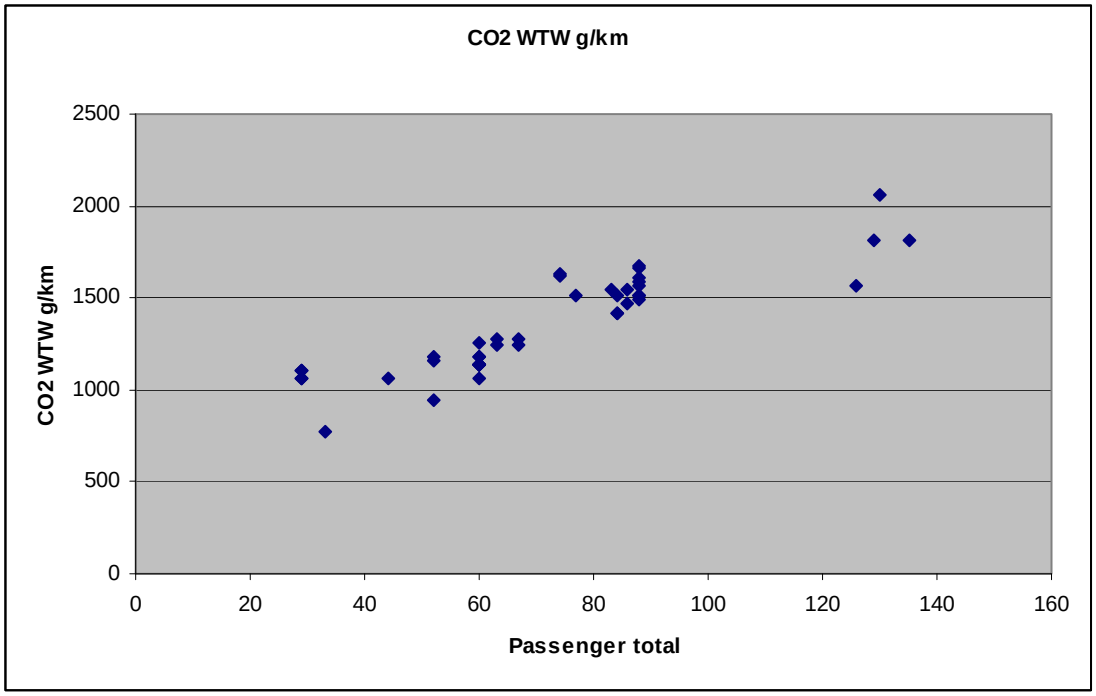
CO2 Target Line
(From LowCVP BWG-P-05-04)

Table 6: Euro 3 CO2 WTW baseline data

Make	Model	Engine	Type	Passenger total	CO2 WTW g/km
Mercedes			SD	33	774
Dennis	Dart		SD	44	1063
Dennis	Dart		SD	52	1157
Optare	Solo		SD	52	1179
DAF	DB250		DD	84	1513
Volvo	B7TL 2 axle		DD	88	1589
DAF	DB250		DD	84	1412
M-B	Citaro		SD	74	1626
Scania	L94		DD	77	1509
Dennis	Trident		DD	88	1566
Volvo	Olympian 3 axle		DD	130	2056
M-B	Citaro		Artic	135	1809
Volvo	Olympian	IVECO	SD	83	1545
Optare		ISB	SD	67	1278
Optare		ISB	SD	67	1244
Marshall		ISB	SD	29	1064
Marshall		ISB	SD	29	1107
Dennis	Dart		SD	60	1133
Dennis	Dart		SD	60	1141
Dennis	Dart		SD	60	1138
Dennis	Dart		SD	60	1178
Dennis	Trident		DD	88	1670
Dennis	Trident		DD	88	1664
Dennis	Trident		DD	88	1513
Dennis	Trident		DD	88	1495
Dennis	Trident		DD	88	1509
Dennis	Trident		DD	126	1569
Dennis	Dart		SD	60	1259
Dennis	Dart		SD	60	1063
Volvo	B7TL		DD	88	1607
M-B	Citaro		SD	74	1625
M-B	Citaro		Artic	129	1812
DAF	DB250		DD	84	1415
Volvo	Olympian	Cummins	DD	86	1472
Volvo	Olympian	IVECO	DD	86	1545
Optare	Optare		SD	63	1278
Optare	Excell		SD	63	1244
Optare	Solo	M-B	SD	52	947
Marshall		ISB	SD	29	1064

Marshall		ISB	SD	29	1107
Dennis	Dart		SD	60	1133
Dennis	Dart		SD	60	1141
Dennis	Dart		SD	60	1138
Dennis	Dart		SD	60	1178

Figure 4: Euro 3 CO2 WTW baseline



slope	9.175097712
intercept	721.5941505
r^2	0.881879021

It was decided by the LowCVP Bus Working Group sub-group that there was a lack of data at the lowest capacity buses. There was a turning up of the CO2 plot and that the above data should be truncated at 44 total passengers (8m Dart). Also repowers were eliminated at this stage. The resultant baseline and target curves are displayed below as reported in LowCVP BWG-P-05-04. The target line (- 30% GHG) was expressed by the following equation:

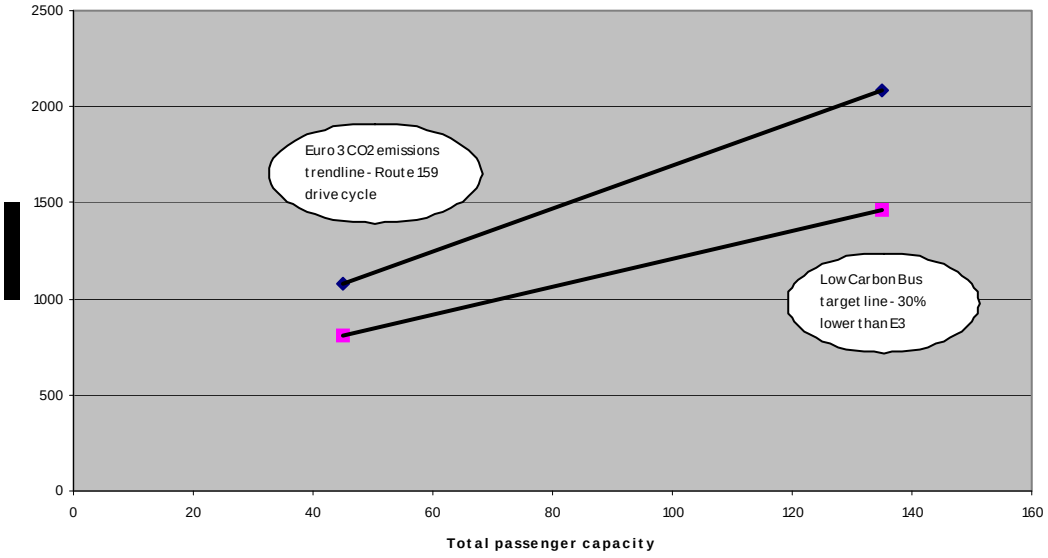
GHG CO2 equivalent (well-to-wheel) g/km =

((7.25 x total number of passengers) + 480)

WTT element was estimated at 14.286% of TTW CO2.

Figure 5 shows the resultant baseline and target line from the exercise.

Figure 5: CO2 target line (from LowCVP BWG-P-05-04)



Appendix 4

Specification
Version 5

Table A: Requirements

Parameter	Requirement
Tier 1 greenhouse gas carbon-dioxide equivalent performance	- 40% (minimum) c.f. Euro 3 equivalent bus on MLTB drive cycle See Table 1 for targets
Tier 2 greenhouse gas carbon-dioxide equivalent performance	- 20% (minimum) c.f. Euro 3 equivalent bus on MLTB drive cycle See Table 1 for targets
Gradeability (with maximum load)	10%
Range / Endurance	250 miles / 400 km
Range (zero emissions) - optional	4 miles / 6.4 km
Drive-by noise performance (exterior)	80 dB(A) as per EU Directive
Drive-by noise performance (interior)	As per current TfL requirements (data to be supplied)
Air quality emissions	Reductions to be obtained on the MLTB drive cycle See Table 2 for targets
Exhaust position (if appropriate)	Non near-side
Refuelling	Once a day
Construction & Use	EU Bus & Coach Directive 2001/ 85
Life cycle assessment (LCA)	ISO 14000 series

Table B: Well-to-wheel greenhouse gas targets

Passenger capacity	Tier 1 (40% reduction)	Tier 2 (20% reduction)
	WTW GHG g/km	WTW GHG g/km
20	535	715
40	659	881
60	784	1046
90	970	1295

Note for the above table the following formulae were used for WTW GHG emissions factors on the whole vehicle MLTB drive cycle based on the original one developed for a 30% reduction:

Tier 1 WTW GHG CO2 equivalent (g/km)

= (((7.25 x total passengers) + 480)) x 0.857)

Tier 2 WTW GHG CO2 equivalent (g/km)

= (((7.25 x total passengers) + 480)) x 1.143)

These expressions may then be simplified as follows:

Tier 1 WTW GHG CO2 equivalent (g/km)

= (6.21 x total passengers) + 411

Tier 2 WTW GHG CO2 equivalent (g/km)

= (8.29 x total passengers) + 549

Table C: NOx & Pm emissions targets

Passenger capacity	NOx	Pm
	g/km	g/km
20	4.32	0.019
40	4.75	0.024
60	5.19	0.030
90	5.85	0.038

Note that the NOx and Pm emissions factors in the above table are to be derived from the whole vehicle MLTB drive cycle.

Note for the above table the following formulae were used for NOx and Pm emissions factors on the whole vehicle MLTB drive cycle:

NOx (g/km)

= ((0.0547 x total passengers) + 9.698) x 0.4

Pm (g/km)

= ((0.001342 x total passengers) + 0.069) x 0.2

The formulae may be rationalised as follows:

NOx (g/km)

= (0.0219 x total passengers) + 3.879

Pm (g/km)

= (0.000268 x total passengers) + 0.0138

These formulae were derived from Euro 3 baseline data linear regression curve fits and application of a ratio of legislation levels for EEV / Euro 6 proposal versus Euro 3. The following ratios were used:

- Euro 6 / EEV NOx relative to Euro3 = 0.4
- Euro 6 / EEV Pm relative to Euro3 = 0.2

There nature of the data gave a poor correlation factor in both NOx and Pm cases. However it was felt that the resultant curves were intuitively close to describing the required emissions targets. Further work may be rquired on this aspect.

Appendix 5

The report provides costing for the viability of low carbon buses and the marginal cost of implementing a Forward Commitment for Low Carbon Buses in Section 7. These calculations are based upon the following assumptions.

Basic cost assumptions relating to Diesel buses

Description	Units	**Diesel** **EGR+DPF**	**Tier 1** **Hybrid**	**Tier 2** **Stop-start+Regen**
Capital Cost				
- batch production		£120,000	£220,000	£150,000
- series production		£120,000	£170,000	£135,000
Maintenance		£5,500	£8,500	£6,000
Fuel Consumption	l/km	0.4	0.24	0.32
Fuel Price	p/l	81.8	81.8	81.8
Fuel Duty	p/l	46	46	46
CO2	g/km	1250	750	1000
km pa	km	50000	50000	50000
Life	Yrs	15	15	15

In addition the following assumptions are made regarding the costs incurred during the phases of the Forward Commitment.

Phase 1 – Demonstration
The following assumptions are made;

- That a number of buses from different suppliers will be demonstrated.
- Each supplier provides 1 bus
- There will be up to 5 suppliers
- The bus will be operated, if successful for up to 7 years
- The bus supplier will provide residual support for demonstration buses.

Phase 2 – Small Fleet Trials
The following assumptions are made;

- Two suppliers successfully complete the first phase
- Each supplier will provide buses for a whole route, assumed to be 8
- Two buses will be required to provide cover due to reliability
- These buses will be batch produced
- The bus supplier will provide residual support for demonstration buses.

Phase 3 – Mass procurement
The following assumptions are made;

- 500 buses are procured

- At this point the buses are as reliable as normal buses
- The buses are produced in series production