

TRANSPORT FOR LONDON

SURFACE TRANSPORT PANEL

**SUBJECT:     HYBRID BUSES**

**DATE:         30 JUNE 2010**

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**1     PURPOSE**

- 1.1 The purpose of this paper is to update the Panel on the hybrid bus trials that have been taking place over the past three to four years and to provide information on the roll-out of further hybrid buses across the fleet.

**2     BACKGROUND**

- 2.1 In 2006, TfL commenced a project to trial diesel electric hybrid bus technology from a number of suppliers in order to assess both the suitability of the technology in an urban environment and the different types of technology being developed for the UK market. In line with the Government's 'Powering Future Vehicles Strategy' published in October 2004, TfL set a target that this technology should achieve a 30 per cent reduction in CO<sub>2</sub> emissions compared to the equivalent diesel bus.
- 2.2 Although London was the first European city to undertake extensive trials of hybrid buses, the technology is already well established in North America with New York, for example, operating in excess of 1,000 hybrid buses<sup>1</sup>. Significant federal government grants to transit authorities in the USA have accelerated the take up of this technology.
- 2.3 The introduction of hybrids into the TfL bus fleet will achieve a number of benefits. Not only will it ensure that TfL continues to be seen at the forefront of technological development but it will also deliver a number of environmental improvements. As hybrids produce fewer carbon emissions compared to diesel buses, the hybrid programme is one of the principal measures that will help TfL achieve its target of a 20 per cent reduction in normalised CO<sub>2</sub> by 2017/18. Delivery of the hybrid programme is also one of the key actions for reducing London's CO<sub>2</sub> emissions identified in the Mayor's draft Climate Change Mitigation and Energy Action Strategy, and for improving air quality in the Mayor's draft Air Quality Strategy. Not only are hybrids cleaner but they are also quieter which, combined with a much smoother ride, will help improve the perception of public transport, ensure it remains attractive and continues to increase passenger patronage well into the future.

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<sup>1</sup> It is worth noting that these vehicles generally use larger engines and that, while similar per cent reductions in fuel consumption have been achieved, the absolute figures are greater than UK diesel buses.

### 3 TECHNOLOGY

- 3.1 The principle of all the hybrid buses which form part of the TfL evaluation is that they are driven by an electric motor (via a battery pack) with a smaller than normal diesel engine running a generator to keep the battery pack charged. Hybrid buses can either be 'series', where there is no direct link between the engine and the bus wheels, with the bus being solely driven by battery, or 'parallel', where the bus is driven by either the battery or directly by the engine.
- 3.2 The manufacturers have chosen different battery types, power control methods and engine sizes. All manufacturers have brake regeneration, which captures braking power to the batteries as standard.
- 3.3 The manufacturers' systems vary as follows:
- (a) **Wrightbus** (single and double deck) – a series system with a lithium ion battery pack and a very small engine, running at constant optimal engine speed, charging the battery pack. This allows the battery pack to vary its state of charge at any given power demand.
  - (b) **ADL** (single and double deck) – a series system with a lithium ion battery pack and a reduced size engine responding in engine speed to the power being requested from the battery pack in driving the bus. Thus, engine speed moves up and down to keep the batteries at a constant state of charge by recharging the batteries immediately as the power is utilised moving the bus.
  - (c) **Volvo** (double deck) – a parallel system with a lithium ion battery pack and a reduced size engine. The smaller engine drives the bus as normal but has a combined generator and electric drive motor integrated into the gearbox that assists propulsion when sufficient power is available from the battery pack. This system provides for a smaller battery pack than full series and a smaller engine than a standard bus by combining both technologies.
  - (d) **Optare** (single deck) – a parallel system with a nichol metal hydride battery pack and a standard size engine. The engine can separately drive the bus in a conventional manner with no electric drive used while re-charging the battery pack. A control system then switches to a separate electrical drive method when power is available. The system can blend both drive methods when the situation is appropriate.

Most types are showing fuel mile per gallon benefits over standard diesel buses on identical routes. The series systems are demonstrating the most miles per gallon (mpg) improvement on inner city routes.

### 4 HYBRID TRIALS

- 4.1 There are currently 56 hybrid buses operating in London from the four different manufacturers as detailed in Section 3. Performance and reliability has varied across the manufacturers, although continuous modifications and up grading of products are leading to improvements based on operational experience.
- 4.2 The New Bus for London will incorporate hybrid technology. The next generation of zero-emission hydrogen fuel-cell buses will also incorporate

hybrid technology allowing an extended operating range compared with the first generation of buses trialled between 2003-2007, which were fuel cell only.

## **5 VEHICLE COMPARISON**

- 5.1 Hybrid buses currently cost approximately £110,000 more than a conventional diesel bus. For example, a hybrid double deck bus for London would cost £300,000 compared with £190,000 for the diesel equivalent. Initial indications are that maintenance costs are about the same as a conventional diesel bus, although replacement of batteries after about five years will require further capital investment. The cost difference for single deck buses would be comparable, though from a lower starting cost.
- 5.2 The double deck buses in the trial fleet are achieving an average of 6.1mpg compared with the benchmark diesel buses at 5mpg. At current fuel prices, taking into account fuel duty rebate and based on average annual mileages, this represents a fuel saving of £4,900 per annum per bus. The results from the single deck trials indicate more variability, but the best performing vehicle is achieving 9.9mpg compared with benchmark of 8.0mpg giving a saving in fuel costs of £3,700 per annum.

## **6 GREEN BUS FUND**

- 6.1 In late 2009, the Department for Transport, through the Green Bus Fund, offered a grant of £30 million to bus operators and tendering authorities to facilitate the introduction of further low carbon buses. TfL was successful in securing £5 million from this fund which has been used to pay the capital premium to the contracted bus operators in order to allow them to purchase or lease an additional 50 buses. These buses will be delivered towards the end of 2010 and will bring the fleet strength to 112 buses. The DfT had planned to allocate a further £15 million of funding during 2010/11 but this has recently been cancelled.

## **7 FUTURE ROLL OUT PLANS**

- 7.1 The current business plan assumes 300 hybrid buses will be in service by 2012 and that all new buses from 2012 onwards will be hybrid. The business plan includes £47 million over the plan period to support the roll-out of hybrids and assumes that the capital premium reduces as volumes increase. If these capital cost reductions are achieved, then the business plan has sufficient funding to allow a fleet total of 300 buses in 2012.
- 7.2 The other barrier to the introduction of hybrid buses to the London market is the reluctance of the commercial leasing market to offer attractive leases for this new technology. Leasing companies are currently unsure of the market for second hand hybrid buses and with no guarantee that the vehicles will be reused in London are taking a cautious view on residual values. This is pushing up the initial lease rentals and TfL continues to explore with a number of these organisations how more attractive leasing arrangements can be arranged.

## **8 RECOMMENDATION**

8.1 The Panel is asked to NOTE the paper.

## **9 CONTACT**

9.1 Contact: David Brown, Managing Director, Surface Transport  
Number: 020 3054 0178  
Email: [DavidBrownMD@tfl.gov.uk](mailto:DavidBrownMD@tfl.gov.uk)