The Mayor's Draft Air Quality Strategy

Response by the Electric Tbus Group

December 2001

Introduction – the Electric Tbus Group

The Electric Tbus Group is a group of private individuals concerned to promote awareness of the opportunities for and benefits of direct electric traction technology, particularly modern electric trolleybus technology, in urban public transport. The group is simultaneously concerned to improve both air quality and public transport in London. We have a website at

http://www.tbus.org.uk/

This submission focuses on air quality issue. It is compiled by:

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The problem - air pollution in London

The Mayor's Strategy notes that London's air quality is the worst in the UK and among the worst in the European Union. Each year, up to twenty-four thousand people die prematurely in Britain from the effects of air pollution. The week-long period of high pollution in December 1991 is estimated to have caused 160 premature deaths in London

Poor air quality provides a disincentive for businesses to create jobs in London. ‘Freedom from pollution’ is an important consideration in the decision-making of international companies when they are considering where to locate. London is only ranked 24th out of 28 cities in Europe for this indicator.

Internal combustion engined vehicles are the main source of London’s air pollution

In London, the most significant emission source is road transport. Two pollutants - nitrogen oxides and fine particles - are the greatest cause for concern. Over half of emissions of nitrogen oxides and over two thirds of fine particle emissions come from road traffic. There are two ways to reduce road vehicle emissions:

1. Reducing traffic and congestion
2. ‘Cleaning’ or reducing emissions from vehicles

The measures in the Strategy focus on reducing these emissions and acknowledge the need to deal with the emissions from London’s large diesel bus fleet by including:

- A major programme to clean London's bus fleet - fitting 800 buses a year with new technology to reduce exhaust emissions
- An on-going programme of replacing older, more polluting buses with more than 1,000 cleaner, modern buses. All 6400 London buses will be Euro II standard or better by 2005.

Alternative traction technologies

The Strategy mentions [battery] *electric cars, hybrid engines and fuel cells* noting that the Mayor will encourage these technologies by promoting the grants available to assist in the cost of purchasing these vehicles and that the Mayor and Transport *for* London are also leading by example in trialling some of this technology.

Direct electric vehicles

However the Strategy, apart from noting that “*Pollution generated from trains is generally not an issue, as most trains are electric*” makes no other reference to direct electric traction. Direct electric vehicles are vehicles where the electric power is fed via a conductor system to the vehicle. Electric trains are direct electric vehicles.

Pollution is not an issue with London’s large fleet of direct electric trains

Direct electric vehicles provide *true* zero emissions – *no* nitrogen oxides, *no* particulates, *no* other pollutants at all. This is *guaranteed under all circumstances*, including ‘idling’, cold running, transient conditions, sub optimal maintenance, etc., *throughout the life* of the vehicle. No proven practicable alternative technology can anywhere near match this, let alone improve on it, technically or economically.

A modern direct electric bus in Basle

In hundreds of towns and cities world-wide such as:-

- Amsterdam
- Arnhem
- Athens
- Basle
- Brussels
- Edmonton
- Geneva
- Gent
- Lausanne
- Lyon
- Melbourne
- Milan
- Moscow
- Munich
- Oslo
- Rotterdam
- San Francisco
- Sao Paulo
- Seattle
- St Petersburg
- Toronto
- Vancouver
- Vienna
- Zurich

the core street transit systems are worked by direct electric vehicles [trolleybuses and trams].

Yet currently London has only 24 such vehicles on its streets [Croydon trams] – a minute number when compared with the diesel fleet of 6,400 vehicles. In contrast in 1950, London had 2,500 direct electric vehicles - the potential today for deploying more than 24 modern direct electric vehicles on London streets *must* be substantial.

One of 24 electric trams in the streets of Croydon [above]- but these true zero emission vehicles are submerged in a fleet of 6,400 diesel buses [below]

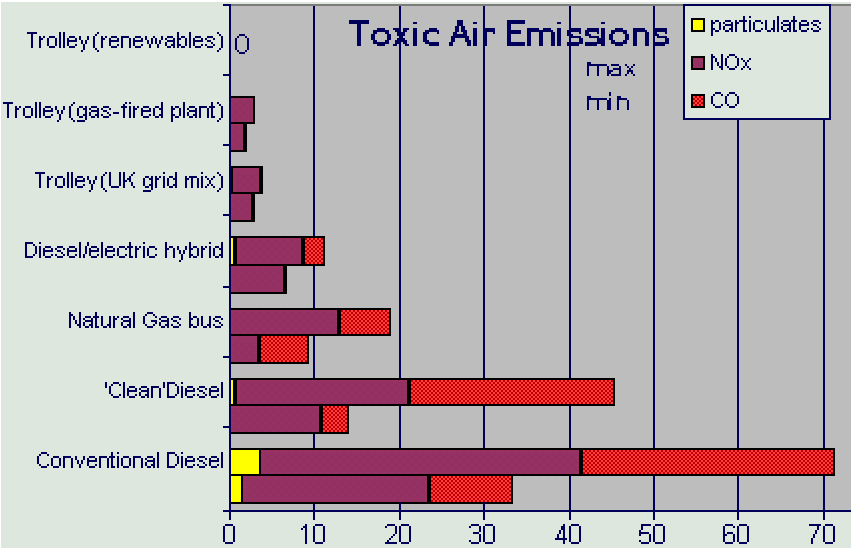
Direct Electric vehicles and the environment

Direct electric vehicles are true zero emissions vehicles in all circumstances so far as the streets are concerned. However, direct electric vehicles may indirectly introduce pollutants into the environment as a whole, but these pollutants are at much lower levels than those from internal combustion engined vehicles and are not pumped directly into the air to be breathed on the streets.

The table below shows comparative air contaminant emissions for particulates, Nitrogen oxides [NOx] and Carbon Monoxide [CO] based on a typical urban bus duty cycle (in g/km) from different categories of internal combustion engined buses compared with an equivalent direct electric bus [trolleybus].

	Particulates	**NOx**	**CO**
Diesel	1.3-3.5	22.0-38.0	10.0-30.0
'Clean' Diesel	0.1-0.35	10.75-21.0	3.1-24.3
Natural Gas	0.016-0.051	3.60-13.0	5.63-6.0
Diesel/Electric Hybrid	0.017-0.23	6.64-8.6	0.08-2.5
Trolley (grid mix)	0-0.2	2.91-3.69	0.056-0.144
Trolley (gas-fired plant)	0	1.98-3.12	0.04-0.06
Trolley (hydro-electric)	0	0	0
Trolley (renewables)	0	0	0

Or presented as a graph:



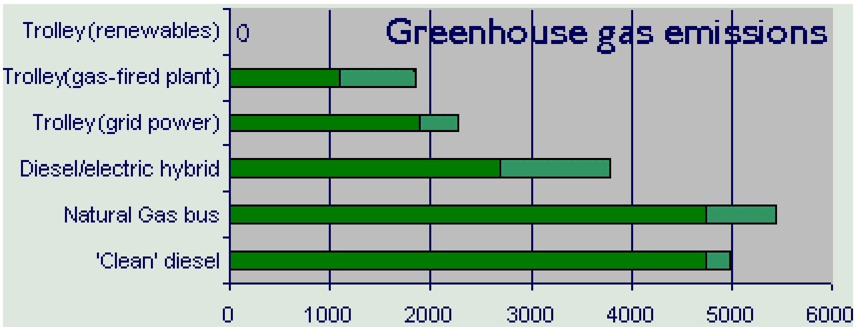
Green House Gases – GHGs

The Strategy does not mention Green House Gases, even though these constitute a serious form of air pollution and the UK has signed up to achieving tough targets for reducing them. The main GHG is Carbon Dioxide [CO2] but Methane [CH4] - 'Natural Gas' - is also a very significant GHG.

When fossil fuels like oil and gas are burned in a power station, not only are they burned more cleanly than in vehicle engines, they are also burned much more efficiently, meaning that less has to be burned and less GHGs result.

A typical modern gas fired power station has a conversion efficiency of around 60%. The best that the most efficient automotive engine [diesel bus engine] can achieve is about 40%. But the automotive engine operates under varying loads and conditions reducing its average efficiency below 30%. In contrast, the power station operates under constant conditions so average efficiency remains around 60%. After allowing for transmission line losses, etc., but including the ability of modern electric vehicles to regenerate power when braking or descending hills, a direct electric vehicle is about twice as fuel and energy efficient as the best internal combustion engined vehicle. Hence, even when driven by fossil fuels burned at power stations, a direct electric vehicle produces only around *one half of* the GHGs that an equivalent internal combustion engined vehicle does. If electricity is produced from 'renewables', no GHGs are produced, of course.

The graph below shows comparative GHG emissions for a typical urban internal bus duty cycle (in g/km) from different categories of internal combustion engined buses compared with an equivalent direct electric bus [trolleybus].



Noise

The Strategy makes only limited mention of noise. However noise is a form or airborne pollution. As well as being very much cleaner than internal combustion engined vehicles, direct electric vehicles are also inherently very much quieter, as the following table shows [all figures in dB – decibels]:

Hearing loss	90+ dB
Diesel bus	80+ dB
CNG bus	75 dB
Fuel cell bus	<70 dB
Trolleybus	50 - 60 dB
Quiet street	60 dB

Because noise is measured on a logarithmic power scale, direct electric buses [trolleybuses] are around *175 times quieter* than diesel buses.

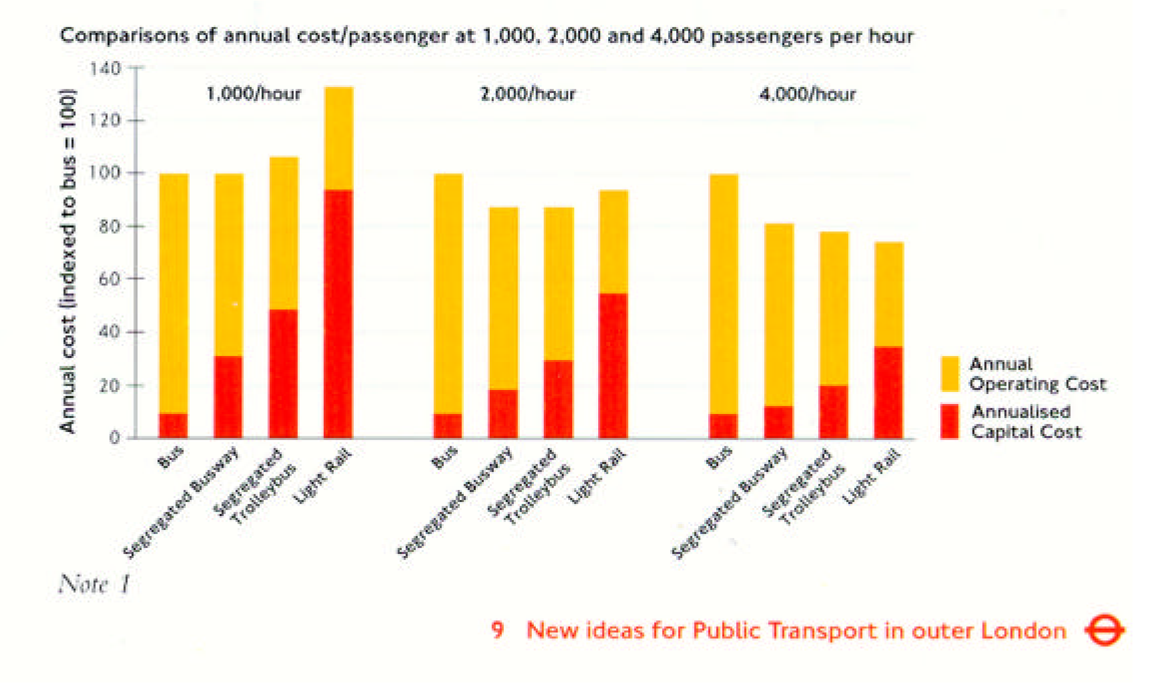
[Above tables and graphs originally compiled by Kevin Brown (University of Alberta/Edmonton Transit System Advisory Board) using data sourced from: Northeast Advanced Vehicle Consortium, U.S. Office of Transportation Technologies, U.S. Environmental Protection Association, BC TransLink, Edmonton Transit System, Edmonton Power, EPCOR, San Francisco Municipal Railway.]

The economics of direct electric vehicles

Electric traction requires a power supply infrastructure. In railway applications this infrastructure is accepted and pays for itself because of the lower maintenance costs, better availability, greater reliability, greater performance and lower real energy usage of electric vehicles [especially if fitted with regeneration] and because of the greater attractiveness to the travelling public of electric vehicles. These features are equally applicable to electric vehicles in the streets.

Comparing the long term economic relative costs of diesel and electric traction, even without reckoning the environmental benefits of electric vehicles, is beset with a number of uncertainties such as the likely future availability and cost of diesel fuel. Also, the economics of direct electric vehicles are more scale dependent – the greater the number of vehicles deployed and the larger the size of network equipped, the lower the unit costs become. However, it is general truism for an urban route or network, that electric costs will *no be more than of the same order as diesel*. One can contrast this, for example, with North American [Vancouver] experience of Compressed Natural Gas [CNG] traction where CNG has been found to be about 70% more expensive than diesel [article in *Buses* magazine July 2000]. Or put another way, the considerable environmental benefits of zero emission direct electric vehicles, come, in effect, for free.

The graph below shows London Transport's 1995 cost comparisons between diesel and electric traction.



The environmental benefits of direct electric traction come, in effect, for free.

This graph shows that at only 1,000 passengers / hour peak capacity, electric traction is only slightly more expensive [about 7%] than diesel while at higher capacities, it is as cheap or cheaper than comparable diesel traction. The comparison focuses on *costs*. North American experience [San Francisco and Seattle] shows that, other factors being equal, direct electric traction is capable of attracting up to 20% more *ridership* [more revenue] than diesel traction. Electric vehicles are significantly more attractive to passengers.

The economics of alternatives

The economics of unproven alternatives to diesel traction such as fuel cells or hybrids will take some years to establish. But it can be said with some certainty regarding urban public transport networks that:

- No technology can improve on the true zero emissions of direct electric vehicles
- Diesel traction is hard to beat economically
- It will be surprising if unproven technology can compete economically with diesel
- It will therefore be also surprising if unproven technology can compete economically with direct electric traction

For example, battery replacement costs are likely be a substantial item in the long term costs of hybrids – the manufacturers of current hybrid cars will only warrant their batteries for three years for instance. And the overall energy efficiency of fuel cells is so low that around a dozen direct electric vehicles can be operated for the energy consumption of one fuel cell vehicle [*Transport 2000 Canada Western Newsletter* November 2000].

Alternatives and the Environment

The long term goals of any traction technology have to include

- Independence from fossil fuels – to avoid availability and GHG problems
- Sustainability – energy from renewable resources
- Zero emissions at point of use
- Minimal emissions into the environment as a whole
- Practicability
- Affordability

Practically speaking, the bulk of renewable energy resources such as wind, wave, solar, and water power, burning biomass, etc., generate electricity. Direct electric traction satisfies all the above criteria. No other 'alternative' can.

In the context of urban public transport systems, therefore electricity just *has* to be the green flexible environmentally friendly sustainable 'fuel' of choice for the future.

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Transport and Air Strategies and the ‘Intermediate Mode’ Projects

A number of trials of alternatives to diesel traction in the streets such as CNG, hybrid and fuel cell buses are planned or ongoing. It will be some considerable time before the full outcomes of these trials regarding such factors as the real practicability and long term economics of these technologies is established.

However the practicability and long term economics of the two proven established technologies – diesel and direct electric traction are already well known. And without pre-empting the results of the trials, it will be surprising if, in the context of busy urban transit routes, the untried technologies can improve on the economics of either of the established technologies or on the environmental friendliness of direct electric technology.

Within the next few months, decisions are expected to be taken on the four proposed intermediate mode transit projects, viz.

1. East London
2. Greenwich Waterfront
3. Cross River
4. West London [Uxbridge Road]

The technology options being considered are:

- Diesel buses
- Electric trolleybuses
- Electric trams [2, 3 and 4 only]

All these projects are for busy routes or networks. Direct electric traction will be economically viable compared with diesel but much more environmentally friendly.

Recommendations

The Electric Tbus Group recommend that as part of the final Air Quality Strategy:

- The Mayor and Transport *for* London should lead by example and, as a matter of policy, determine that *only electric traction options* [trams or trolleybuses] should be considered for the intermediate mode schemes.
- And that, in the longer term, when the outcomes of the trials of the technological alternatives to diesel traction are known and operating experience with intermediate mode schemes has been built up, that extension of direct electric traction to diesel bus routes be actively considered.