

The New Bus for London – Diesel/electric hybrid

Clean Fleets case study

- First bus specifically designed for London in over 50 years.
- Iconic design combined with modern hybrid technology and expectations.
- Emits less than half the CO₂ and NO_x than a current London diesel bus in service
- Largest order of hybrid buses ever placed in Europe.



Contract tendered

- Contract to design, manufacture and supply 600 diesel electric hybrid buses to Transport for London between 2012 and 2016.
- Tender specification based on initial public design competition.
- Highly publicised project due to political and design factors.

Targets and planning considerations

A Mayoral priority project in 2008, who wanted an updated version of the classic Routemaster double-decker bus, with very high environmental credentials. The Mayor set the target to reduce London's CO₂ emissions from its 1990 level by 60% in 2025. As of 2008, transportation accounted for 22% of London's CO₂ emissions with road based modes comprising 81% of this total. The Mayor targeted the sector for not only reducing its CO₂ emissions but also improving air quality and quality of life for Londoners.

It was planned that the new buses would operate on Central London routes. The bus began service in February 2012 on route 38 and by July seven buses were in operation on the route. In June 2013 32 buses began operating on the 24 hour route 24. It is aimed that by May 2016 there will be a full roll out of 600 vehicles.

Transport for London, who runs the buses in London, have made it a big policy to introduce and operate green buses throughout its vast bus network. Overall London has Europe's largest fleet of green buses and is looking to increase its green fleet. As of 2012 all new buses entering the fleet are expected to be hybrid. A number of hydrogen buses are currently in the fleet, with electric buses also being purchased and will be trialled. By 2016 there will be more than 1,700 hybrid buses in service in London of which 600 will be the New Buses for London (NBfL). Overall hybrid buses will represent 20 per cent of the total bus fleet (8,500 buses).



Procurement approach

There was a public competition launch in July 2008 with the objective to harvest ideas and concepts for the new bus. The competition was open to design studios, colleges and the general public. There were over 700 entries from all over the World. Some of ideas and concepts the competition produced allowed TfL to further develop its tender specification for the NBfL.

Once the performance specification had been created a European procurement exercise started in February 2009. There were six initial expressions of interest and on the 23rd December 2013, Wrightbus of Ballymena, Northern Ireland were awarded the contract.

The contract was a competitive, fixed price deal. The fixed price was chosen as it removes the risk and uncertainty of higher production and material costs and inflation over the next four years. The fixed price not only included the 600 buses, but also the design & development of the bus, a mock-up, development test vehicle & testing and an initial batch of 6 prototypes vehicles.

To help create the overall concept design of the bus, Heatherwick Studio a renowned design team worked alongside TfL and Wrightbus. Heatherwick Studio created the unique shape and design of the bus with the final design being announced in May 2010.

Clean Vehicle Directive (CVD) Methodology

For this contract TfL used CVD Methodology Option 1, with contractual targets for emissions set at the tender stage. These targets were based on the Millbrook London Transport Bus (MLTB) test cycle. This test cycle recreates the conditions of a Route 159 bus which travels from Brixton (South London) to Baker Street (North Central London) with all the accompanying gear changes, calls at bus stops, acceleration, braking and waiting time at traffic lights. The MLTB is a chassis dynamometer test.

The MLTB produced a number of aspirational emission targets, TfL wanted the New Bus for London to meet. These were Carbon Dioxide (CO₂), Nitrogen Oxide (NO_x), Particulate Matter (PM) and Hydrocarbons (HC). The target levels for these emissions are set out in the table below:

Emission	CO ₂ g/km	NO _x g/km	PM g/km	HC g/km
Target	750	5.00	0.030	0.015

Contract Monitoring and Management

The NBfL contract included a number of deliverables that had to be met. There are strict dates to meet in terms of rolling out the buses into operation. The route 24 had to be served by NBfLs on the 22nd June 2013. The route 11 is next with rollout date being the 22nd September 2013. Two further routes will be served by NBfL by the end of 2013.

The contract states that approximately 200 vehicles will be delivered to TfL in 2014, 250 in 2015 with the remainder in 2016.

To meet legal requirements the contract states that from 2014 all the new NBfLs manufactured must be fitted with Euro 6 engines.

The contract provides that TfL will have sufficient intellectual property rights to enable other manufacturers to supply vehicles of this style in the event that their usage represents a material proportion of the London bus fleet.

The contract also allows for Wrightbus to supply NBfL to the bus operators at capped prices.



Results

There were six initial expressions of interest, with Wrightbus of Ballymena, Northern Ireland being awarded the contract on the 23rd December 2013.

The cost was slightly higher than foreseen at the beginning. This is mainly due to the higher specification of the NBfL. Over the lifetime of the buses TfL expect them to produce a substantial saving.

When the NBfL was announced, a lot of work was done to let the public know that the new bus would be much more environmentally friendly than a conventional bus. At events and throughout the press both the Mayor and TfL highlighted how the new bus would produce substantially fewer emissions of carbon dioxide, oxides of nitrogen and particulate matter.

The previously mentioned public competition for initial ideas and concepts greatly helped create interest in the project and a buzz around it. The 700 entries from the competition came from a wide range of people and the London Transport Museum held an exhibition showcasing the submissions. TfL also organised a public consultation on the new buses to gather public feedback and answer questions from the general public.

Customer research carried out in summer 2012 confirms the NBfL is well liked by customers, scoring very high satisfaction among passengers who particularly rate its smooth ride, comfort and quietness. The NBfL also won the prestigious Viva Shield by the Worshipful Company of Carmen. The award founded in 1956, it honours transport innovation, improvement or development in Europe.

Technology

The NBfL uses the latest green diesel-electric hybrid technology and it is deemed by TfL to be the best performing bus of its kind in the World. It works by having a battery pack which powers the electric motor which drives the wheels on the bus. The battery is charged by a generator and through regenerative braking (where the system recycles the energy lost during the braking motion). Stop-start technology means the engine only runs when it needs to charge the battery. The bus is a series diesel-electric hybrid with a Cummins ISBe4, 4.5l turbo diesel (currently EuroV certified). The bus has valance lithium phosphate battery energy storage and a Siemens/ZF drive train with permanent magnet electric motor.

The performance specification created for the NBfL was completely unique.

Costs

The TfL board decided to buy the 600 buses outright, which allowed it to get a lower unit price.

The overall cost for all 600 buses will be £212 million (€250 million).

At today's prices the buses cost around £326,000. Whilst being more expensive than a standard diesel double-decker bus, this is broadly comparable with a standard hybrid double-decker bus. The price difference is accounted for by the much higher specification of the new bus compared to a standard hybrid bus, for example the innovative three-door, two-staircase design. The unique and iconic design of the NBfL also resulted in it being more expensive than a standard looking double-decker model.

The average price of a new bus over the life of the contract will be £354,500. This cost includes inflation, technical upgrades and any mandatory changes.

Even taking into account the marginally higher initial cost of the buses, a multi-million pound saving will be delivered over the 14 years of operation the buses will have. One of the reasons behind this is that it is more fuel efficient than a comparable average hybrid. Over



their 14-year lifetime each NBfL is estimated to roughly save £127,000 (€148,000) in fuel compared to the average hybrid. This estimate uses August 2013 fuel prices and that each bus will travel roughly 90,000km per year over each 14 years.

In 2016 when all 600 buses are in operation, they will roughly account for 7% of the total TfL Bus fleet.

Environmental impacts

The NBfL helps reduce the CO₂ emissions in London by around 20,000 tonnes a year. In test conditions the NBfL produced around half the carbon dioxide and a quarter of the particulate matter and nitrogen oxides of conventional diesel buses and is more fuel efficient. The CO₂ emissions from the NBfL are tailpipe emissions only, as the vehicle is not charged externally. The battery power that the bus uses comes from the vehicle's regenerative braking system.

In recent emissions tests a prototype bus, that had been in passenger service for eight months and that had driven more than 15,000 miles, was found to emit a quarter of the NO_x and PM of a fleet average hybrid bus and 20 per cent less CO₂.

Below is a table of results from a recent emission test based on the MLTB test.

MLTB	CO ₂ g/km	Economy Mpg	NO _x g/km	PM g/km	HC g/km
New Bus for London target	750	10.3	5.00	0.030	0.015
New Bus for London certified result (EuroV)	690	10.8	2.048	0.012	0.000
Average Hybrid (EuroV)	864	8.6	7.70	0.048	-
Average Diesel (EuroV)	1295	5.8	9.3	0.048	-

The Euro 6 engine that will be fitted to the buses from 2014 will deliver even lower PM and NO_x emissions. The exact levels of the Euro 6 aren't currently known as an NBfL with a Euro 6 engine hasn't been tested on the MLTB yet.

Lessons learned

When the NBfL was introduced there were some slight problems and issues. In the summer of 2013 London experienced a heat wave with a number of high temperatures. This led to some slight issues with the ventilation and air chill systems within the NBfL. Customers were complaining due to the high temperatures within the bus, especially on the top deck. The high temperatures were a result of a manufacturing and operating failure, which were quickly fixed by Wrightbus. Therefore all the new NBfL being manufactured will have their ventilation and air chill systems tested before being placed on operation.

Eight NBfL's are operating on Route 38 alongside another model without the hop-on/off back. Although both models serve the same route some customers are confused by the two different models so to mitigate this, the NBfL's back doors are now to be closed on the route 38.

There has been work on reducing the weight of the buses, as the prototypes operating on the route 38 have a kerb weight of 12.650 tonnes. The NBfL's that were put into service on route 24 have a kerb weight of 12.460 tonnes and more work is being done to reduce the weight.



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