

Nottingham Ethanol Bus Trial

October 2010

Summary

This note summarises the results of a two year trial of bioethanol buses in Nottingham.

The trial has: met emission reduction targets; been operationally successful; been favourably received by the travelling public; and has potential for further expansion to other vehicles.

However, there remains a fundamental problem with developing a business case for ethanol, since fuel costs are around 100 per cent higher than conventional diesel. This is mainly due to current national taxation policies for this type of fuel in relation to conventional diesel. It is argued that strong national lobbying is required to change this situation.



Introduction

Three ethanol powered buses, along with one diesel bus as a control, have been running on Nottingham City Transport (NCT) Route 30 Ecolink service since April 2008.

In addition, a bespoke fuelling station has been built at the NCT Depot on Lower Parliament St, positioned to be accessed by other companies and vehicle types in the future, if required.

The total cost for the buses and fuel installation of £520K was secured by Nottingham City Council (NCC) via a bid to the East Midlands Development Agency. NCC are responsible for the implementation, formal monitoring and evaluation of the trial. On-going additional running costs are currently funded by Nottingham City Council.

Fuel and vehicles

At present only Scania manufacture buses that run on E95 ethanol and there is only one supplier of E95, Sekab. Both of these are Swedish companies.

E95 is a 95 per cent bioethanol and 5 per cent ignition improver mix. Sekab owns patents for the 5 per cent ignition improver and the additive manufacturing process.



Operating Costs

As ethanol has a lower energy density than diesel, comparatively more fuel is used. This is currently 1.17 kms per litre compared with 2.22 kms per litre for diesel.

The latest batch of ethanol (at time of writing) cost £1.21 per litre, compared to £0.98 per litre for diesel.

Current taxation regulations give a rebate on ethanol of £0.5719 per litre and a rebate on diesel of £0.4321 per litre.

The annual additional fuel cost of an ethanol bus compared to a diesel equivalent is around £25,000.

There have been no additional operating costs, other than for ethanol-specific engine oil which is some £1000 per year per bus extra.

In addition, the capital costs of such buses are around £40k per bus, adding some £4k per bus per annum to depreciation costs.

The fuel cost of E95 per km has been consistently higher than the cost of diesel throughout the project. This is partly due to the small batch size of each order and it is felt that a reduction of some 15-20 per cent might be achieved for larger orders. In addition, diesel prices have seen a steady upward trend in the past few years. This means the difference in price between ethanol and diesel is likely to fall in the future.

However, it is felt that even with such trends, the additional cost is unlikely to fall below £20k per bus per annum. For a fleet the size of NCT's, this would amount to additional costs of over £6m per annum if rolled-out fleetwide.

Clearly, a significant change in government taxation policy towards ethanol is required in order to expand its use. Such a policy has been adopted in Sweden, resulting in a countrywide roll-out of its use across many bus fleets.

Ethanol Supply

For the duration of this trial the ethanol used was derived from wood waste imported from Sweden.

British Sugar currently produces 55,000 tonnes of bioethanol per year at their Wissington factory in Norfolk. The product is made from 100 per cent UK sourced Sugar Beet. Currently the entire product is sold as 100 per cent ethanol (E100) to UK oil companies who are blending it with petrol at a rate of around 3.5 per cent.

UK HMRC Excise regulations state that all UK produced ethanol must be denatured to ensure that it cannot be sold into the potable alcohol market. In the UK the only approved denaturants are Methanol, or Gasoline. The chemical package that Sekab sell to ensure that E95 works in bus engines is not compatible with either Methanol or Gasoline. Because the E95 that Sekab produce complies with Swedish regulations it is therefore accepted as an import into the UK, while the British Sugar product that is manufactured in the UK is unable to be denatured in line with Sekab's requirements.

The graphic is a vertical rectangular advertisement with a blue background. At the top left, there is a logo for 'ecolink' featuring a stylized green flower icon to the left of the word 'ecolink' in white lowercase letters. Below the logo, the text 'This bus runs on ethanol' is written in a bold, white, sans-serif font. Underneath this, in a smaller white font, is the text: 'Find out more about the ecolink project, ethanol fuel and our plans to locally source this fuel from sugar beet or wood.' At the bottom of the text block, the website address 'www.nottinghamcity.gov.uk/ecolink' is provided in white. The bottom right corner of the graphic shows a photograph of a large pile of light-brown wood chips or biomass. In the bottom left corner, there are small logos for 'Nottingham City Council' and 'Nottingham City Transport'.

Greenhouse gas emissions

The reduction in GHG emissions depends strongly on the source of the ethanol. Using cellulosic ethanol, the reduction in GHG can be up to 87 per cent relative to petrol.

The 3 ethanol buses in the NCT fleet have generated annual savings in CO₂ emissions of 258 tonnes. So far the impact of the trial on Nottingham is a reduction in CO₂ emissions of 774 tonnes.



Air quality

As the ethanol is burned in an optimised, compression ignition engine significantly lower emissions are produced. Typically Nitrous Oxides are reduced by 28 per cent, Carbon Monoxide by 80 per cent and particulates by 60 per cent when compared to diesel.

Life Cycle Analysis

Ethanol is an alcohol usually produced by fermentation of sugar. The sugar can be derived from Sugar Beet or Cane or can be converted from starches such as those found in crops i.e. it is carbon neutral. According to Scania, world biofuel production currently uses only 1.5 per cent of the available land available for agriculture.

For the duration of this trial ethanol derived from wood waste imported from Sweden has been used.

The energy balance of ethanol (in other words the energy content in a gallon of ethanol compared to the fossil energy used to produce that gallon of ethanol) is 1.28 for wood-based ethanol (compare that to a ratio of 0.81 for petrol). The Nottingham trial has therefore saved 39000 gallons of petrol equivalent to date.

Passengers

The buses have carried over 1.3 million passengers over 390,000 miles over the duration of the trial. There has been little difference in overall usage, but a slightly higher level of usage than other similar routes on the network.

Detailed passenger surveys showed the following:-

- 85 per cent of respondents were aware that ethanol-fuelled buses were used on the Ecolink 30 service.
- Only 18 per cent were aware that each bus saved c.30 tonnes of CO₂ each year.
- 41 per cent did know that ethanol could be produced from Sugar Beet, Sugar Cane or wood by-products.
- 90 per cent support further use of alternatively fuelled buses and 71 per cent of these justified their support on environmental grounds alone.
- 23 per cent claimed to take the bus for environmental reasons.

City - Wollaton Vale		Ecolink 30	
Monday to Friday - to Wollaton Vale			
City, Victoria Centre	0650 0720 0740 0800 0830	every	1030 1055 1620 1635 1650
Bramcote Ln Shops	0700 0730 0750 0810 0840	20	1600 1624 1647 1702 1717
Wollaton Vale	0710 0745 0805 0825 0855	mins	1615 1631 1654 1709 1724
City, Victoria Centre	1710 1730 1745 1800	every	2000 2100 2200 2300
Bramcote Ln Shops	1730 1757 1812 1819	30	2019 2119 2219 2319
Wollaton Vale	1744 1804 1819 1826	mins	2026 2126 2226 2326
Saturdays			
City, Victoria Centre	0730 0820 0830	every	1730 every 2000 2100 2200 2300
Bramcote Ln Shops	0800 0830 0850	20	1740 30 2019 2119 2219 2319
Wollaton Vale	0815 0845 0915	mins	1756 mins 2026 2126 2226 2326
Sundays			
City, Victoria Centre	0835	every	2135 2240
Bramcote Ln Shops	0854	60	2154 2259
Wollaton Vale	1001	mins	2201 2306

www.nct.co.uk

Conclusion

The technology is available and works, the fuel can be produced in a sustainable way and can reduce greenhouse gas emissions and local air pollution.



Although bioethanol buses cost more to purchase and operate than diesel buses, they are reliable and appreciated by drivers and passengers.

E95 ethanol can be safely handled at depots and has potential for wider use in heavy vehicles such as refuse trucks.

The use of high blend mixtures of bioethanol in transport has a significant contribution to make in meeting the EU target of 10 per cent alternative fuels in road transport by 2020. Sales volumes are directly related to price e.g. the cost of ethanol in Stockholm is around £0.25 per litre cheaper.

This work currently makes a significant contribution to achieving targets for inclusion of renewable fuels in road transport and is also one way to implement the Clean Vehicles Directive, but funding is needed to spread investment risks.

However, the market will only develop if market barriers are dealt with on a European and national level.

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