TRIAL OF BIOMETHANE VEHICLES BY BRADFORD CITY COUNCIL

FINAL REPORT – DRAFT

The key findings of this report are:

- The gas-fuelled vehicles were all able to perform their duties as well as equivalent diesel vehicles, and were well liked by the drivers.
- The gas Sprinter van was tested back to back with a diesel equivalent, and performed well in terms of fuel use, in line with previous trials.
- Based on the Sprinter results, replacing Bradford's minibus fleet with gas-fuelled vehicles running on biomethane from the grid would save around:
  - £916 per vehicle per year in running cost
  - A total of 594 tonnes of greenhouse gas emissions across the fleet
- Much larger savings in cost and greenhouse gas emissions would probably be possible by running refuse collection vehicles on gas, due to their high fuel use per vehicle

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DESCRIPTION OF THE TRIAL

VEHICLES AND ROUTES

Several different gas vehicles were trialled by Bradford City Council between 5th September 2012 and 24th October 2012. These were a Mercedes Sprinter panel van, a Mercedes Sprinter mini-bus and a Mercedes Econic refuse collection vehicle. A diesel equivalent of the Sprinter van was also trialled on the same routes to compare fuel consumption. All of the vehicles had multiple drivers during the trial. Summary details are provided for each vehicle below.

Mercedes-Benz Sprinter panel van:

- Tested from 5th September to 15th October
- Used on Post Route 2, covering ~80 miles/day, mixture of urban and inter-urban driving
- Diesel equivalent vehicle tested 20th November to 4th December on the same route

Mercedes-Benz Sprinter minibus:

- First vehicle received 5th September, not used due to technical issues
- Replacement vehicle tested 1st October to 22nd October
- Used on Post Route 1, covering ~30 miles/day, mostly urban driving

Mercedes-Benz Econic refuse collection vehicle:

- On loan from Leeds City Council
- Tested 23rd and 24th October

FUEL SUPPLY

A temporary fuelling station was supplied for the duration of the trial by Chesterfield Biogas. The station, shown in the figure (right), consisted of a bank of gas storage tanks, plus a dispenser.

The station did not include a compressor. As a result of this, gas could only be supplied to vehicles at the pressure in the storage tanks – as the tanks were emptied the pressure dropped, meaning vehicle fuel tanks could not be 'filled' to their maximum pressure.

The gas itself was natural gas imported through Avonmouth and supplied by Hardstaff Group.

TRIAL RESULTS

FUEL CONSUMPTION

The fuel consumption of all the vehicles is summarised in the table below.

Vehicle	Distance covered	Fuel used	Fuel/distance
Gas	km	kg	kg/km
Sprinter van	2,274	231.2	0.10
Sprinter minibus	366	57	0.16
Econic RCV	37	47	1.27
Diesel	km	litre	litre/km
Sprinter van	602	63	0.10

Notes:

Distances shown are the distances corresponding to the fuel use shown in the table. In most cases this is the full distance covered in the trial, but for two of the vehicles there was some ambiguity in some of the fuelling data, so only the period of 'clean' data was used and shown here.

Fuel used has been slightly adjusted to take account of the dropping pressure in the filling station. In calculating the fuel used per unit of distance, the most accurate method is to divide total fuel used by total distance. However, this assumes that the vehicle fuel tank is full at the start of the period evaluated, and filled to the same level at the last fuelling event included. This latter assumption is clearly not true, since the pressure in the filling station dropped throughout the trial. In fact a steady downward trend in the total fuel supplied at each filling event can be seen over the course of the trial. Based on this trend, an extra 10 kg of fuel has been added to the total for the gas van, and an extra 5 kg has been added to the total for the minibus.

DRIVER PERCEPTION

Drivers reported all the vehicles were 'nice to drive', noting that they were quieter than their diesel equivalents while having similar levels of performance. Drivers also adapted quickly to the fuelling of the vehicles. The only problem noted was that of often having to fill up more than once per day – however, this was due to the lack of a compressor on the filling station, and would not be a problem if a permanent station were to be installed.

CONCLUSIONS – USE OF GAS IN WIDER BRADFORD COUNCIL FLEET

PERFORMANCE OF GAS VANS COMPARED TO DIESEL COMPARATORS

It is generally expected that vehicles running on 100% gas will use roughly 1 kg of gas for every 1 litre of diesel used by a diesel vehicle of equivalent performance. 1 kg of gas contains approximately 50 MJ of energy, whereas 1 litre of diesel contains approximately 36 MJ of energy. A diesel engine runs on compression ignition, whereas a gas vehicle requires spark ignition, with the latter being roughly 25-30% less efficient.

With this in mind, the following observations can be made in this trial:

1. The Sprinter van performed more or less as expected, with the gas variant consuming 0.1 kg gas per km, and the diesel variant consuming 0.1 litres diesel per km.

2. The gas consumption of the Econic RCV was almost identical to its gas consumption when in use in Leeds.

Greenhouse Gas (GHG) saving

Although a spark-ignition gas engine is less efficient than a diesel engine, the chemical composition of gas means that less CO_2 is generated for each unit of energy used. Based on the trial results for the Sprinter van, the following GHG savings (vs 100% diesel) have been calculated on a 'well-to-wheels' basis. Five different scenarios are considered:

- Using 5% biodiesel (as is in fact the case for UK diesel)
- Using natural (fossil) gas from the low pressure (local) grid at around 1 bar
- Using natural gas from a station connected to the LTS gas main at around 7-10 bar
- Using biomethane supplied by tanker in a station like the one currently installed in Leeds
- Using biomethane supplied through the gas grid.

Scenario	GHG saving vs 100% diesel
5% biodiesel	2% to -1.5% depending on ILUC estimate
Natural gas supplied via the local gas grid	-2%
Natural gas supplied via high pressure gas grid	1%
Biomethane supplied by tanker (station like Leeds)	61%
Certified biomethane supplied via the local gas grid	76%

It can be seen from the table that while using biodiesel may offer some GHG saving, this is by no means certain. This is due to the effects of Indirect Land Use Change (ILUC), for which the EU has yet to agree a calculation methodology. Most biodiesel in the EU comes from rapeseed oil, for which the GHG saving is assumed to be around 40% before ILUC is considered – translating to a 2% saving for a 5% biodiesel blend. However, once ILUC is included, by the worst estimates biodiesel may have 35% greater GHG emissions than fossil diesel (translating to a -1.5% saving vs diesel as shown in the table.)

Using natural gas would make little difference to GHG emissions overall, as it's lower emissions per unit energy are offset by the lower efficiency of the engine. If the gas is taken from the local low pressure grid then based on the numbers from this (limited) trial there would be a slight increase in GHG emissions. However, it is understood that Bradford City Council may be able to site a filling station on a higher pressure gas main, at around 7-10bar pressure, which would lower the energy required for compression and reduce the GHG emissions by around 3%.

Using biomethane would confer much larger GHG savings, as it is basically 'carbon neutral' at source. Biomethane could also be purchased as a blend with natural gas, whether supplied by tanker or the grid.

AIR QUALITY BENEFITS

Running vehicles on gas also confers considerable air quality benefits. All of the gas vehicles tested exceed the requirement of the Euro V standard, achieving the voluntary 'EEV' (Enhanced Environmentally friendly Vehicle) standard.

All gas vehicles have inherently low emissions of cancer-causing particulates, the lowest of any fuel, and considerably below the Euro 6 standard. With regard to NOx emissions, although evidence thus far on Euro VI is limited, available studies suggest that gas vehicles (combined with 3-way catalysts) may also achieve the lowest emissions both in tests, and especially in-use on urban drive-cycles.

POTENTIAL COST AND GHG SAVINGS FROM RUNNING BRADFORD VEHICLES ON GAS

MINIBUS FLEET

As an example of the potential benefits of running on gas, consider Bradford City Council's fleet of approximately 85 minibuses. In 2009 these vehicles currently covered 926,866 miles, using 245,835 litres of diesel. The cost of this fuel was £1.16 per litre, £286,802 in total, and using it would have led to over 781 tonnes of GHG emissions.

Gas is considerably cheaper than diesel, especially given its lower level of fuel duty. When comparing prices, the following elements must be considered:

- Fuel duty – 29 pence/kg
- Electricity used by the compressor – 4 pence/kg (this is a conservative estimate)

Once these are factored in, natural gas from the grid will cost between £0.60 and £0.85per kg when used as a vehicle fuel, but for a user like Bradford City Council probably around £0.66. Biomethane from the grid is likely to be available at between £0.75 and £0.95. In both cases the price obtained will be dependent on the volume of gas purchased and the length of the contract. *(Natural gas prices based on the 'Dukes' digest of energy statistics, for the 3rd quarter of 2012, biomethane prices based on personal communications.)*

Comparing these prices with a diesel price of £1.16 per litre, running Bradford's mini-bus fleet on gas would achieve the following:

- Natural gas - £1,476 per vehicle/year, or £125,500 overall, and significant air quality benefits
- Biomethane - £916 per vehicle/year, £77,842 in total, plus 594 tonnes of GHG emissions savings

This must be set against the extra cost of vehicles and infrastructure, and the best savings would be achieved by first replacing vehicles with the highest fuel consumption each, most likely the RCV fleet.

RCV FLEET – RESULTS FROM LEEDS

RCVs in Leeds, like the Econic borrowed for this trial, cover an average of 16,226 km/year, and use 12,828 litres of diesel and 830 litres of AdBlue. Running these vehicles on natural gas would save £8,089 per vehicle per year, while running them on biomethane (at the price above) would save £5,517.

CASE STUDY: LEEDS CITY COUNCIL RCV TRIAL

- Vehicles: 5 refuse collection vehicles, 6 car-derived vans
- Station: 3.5t store of liquid biomethane, dispensing compressed biomethane, not currently publicly accessible
- Location: Leeds

Leeds City Council began trialling a gas powered refuse collection vehicle (RCV) in June 2009, following a Green Fleet Review. The review identified that while RCVs accounted for just 7% of the council fleet, they consumed 25% of its fuel – making a disproportionate contribution to pollution and costs. Gas vehicles were identified as one solution to this problem.

The vehicle trialled was a Mercedes-Benz Econic 2628LLG 26t chassis in a 4x2 configuration with a steering rear axle. Gas is stored in banks of 4x80 litre tanks, one on each side of the vehicle, giving 640 litres of gas at 200 bar. The vehicle has a Faun Variopress body, and a Terberg Omnidel bin lift.

The trial was successful in demonstrating that the vehicle could perform the duties required reliably, while saving money on fuel. Following the trial, the council invested in a permanent station, with the help of the Infrastructure Grants Programme. During the trial, all the gas used was liquefied biomethane, supplied from GasRec via Gas Container Services.

The council also approved further vehicle purchases. Six Caddy vans running on gas have been in service since September 2012, and a further four Econic RCVs entered service in early 2013. Another Caddy is due to enter service, and purchases of three more RCVs are approved pending identification of suitable routes and operating locations.

(For further detail on this trial, see 'Leeds Biomethane Trial Report' at http://www.cenex.co.uk/resources)