Department for Transport

Department for Transport
Great Minster House
76 Marsham Street
London
SW1 P 4DR

Web Site: www.dft.gov.uk

Our Ref: F0007122

11 January 2010

Dear XXXX

Request for Information ref: F0007122

Thank you for request for information about a feasibility study for a road vehicle biomethane demonstration project received on 24 November 2010. This has been dealt with under the Freedom of Information Act 2000 and a copy of the information is enclosed.

The findings of the feasibility study will be valuable in addressing how biomethane can contribute to our ambitious renewable energy goals, and officials at the Department for Transport will be investigating routes to encourage the uptake of this sustainable renewable fuel.

The Government's Coalition Agreement contained a commitment to introduce "measures to promote a huge increase in energy from waste through anaerobic digestion". Defra and DECC recently published an Anaerobic Digestion Framework which begins to address the role of biomethane from anaerobic digestion (AD) as a transport fuel. This can be found at:

http://ww2.defra.gov.uk/news/2010/12/01/anaerobic-digestion-framework-101130/

This document is intended to provide a starting point for collaborative work between government, industry and a wide range of interested parties to produce agreement on a programme of work which will be delivered in partnership. Further work now needs to be done in order to agree and publish a joint industry and Government AD framework in spring 2011.

One of the specific work themes within the framework is about building markets for biomethane for transport fuels. DfT will be working with Defra, other Government Departments and industry to develop an action plan to address the question of how we ensure that operators can make the best use of biomethane for transport fuels.

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If you have any queries about this letter, please contact me. Please remember to quote the reference number above in any future communications.

Yours sincerely,

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Information Commissioner's Office
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SK9 5AF

Feasibility Study for a Road Vehicle Biomethane Demonstration Project

Final report to the D*f*T

ED49998
22nd June 2010

Executive Summary

This study assesses the feasibility of the Department for Transport successfully carrying out a trial or demonstration of vehicles powered by biomethane during the financial year 2010-11. It provides an outline of the benefits associated with the uptake of biomethane as a fuel for council owned and heavy duty vehicles (HDVs), and an overview of the barriers to their deployment and how a demonstration programme might help to overcome them. Finally, it compares three options for the administration and delivery of funding for a demonstration, and recommends one, with a clear rationale.

This study is based on interviews with 43 different stakeholders in the industry, supported by desk-based research. The stakeholders interviewed included fuel providers, equipment providers, vehicle providers, fleet operators, local authorities, industry consultants, researchers and government agencies.

This report agrees with significant recent work completed by Cenex and the Carbon Trust that the use of biomethane in vehicles has the potential to offer significant cost and CO_2 savings. The use of methane gas (either natural or biomethane) also offers a range of other benefits, including reduced air quality pollutant emissions, noise reduction, and in the long term, energy security and supply.

The ‘well to wheel’ CO_2e emissions savings from using methane gas range from around 10% if using natural gas, to as much as 100% (or even more, if methane emissions are avoided) using biomethane. The wide range of savings reflects the fact that there are two different vehicle technologies available, and that there are different lifecycle benefits associated with different sources of biomethane. It seems likely that most vehicles running on biomethane will achieve a saving of 30-65%, higher than most other options available for reducing HDV emissions, and achieved in tandem with air quality benefits rather than in conflict with them.

Biomethane is produced by upgrading ‘biogas’ – the gas can be produced in numerous ways and the most common is via anaerobic digestion of organic matter. Biogas is typically 35-65% methane, and biomethane is 95-98% methane. The main sources of biogas are landfill sites, sewage treatment plants and Anaerobic Digestion (AD) plants treating a variety of feetstocks including food waste and agricultural wastes.

Although most biogas is currently used for electricity production, there are many sources that could produce biomethane for transport. Government incentives for renewable electricity are such that most new AD plants see electricity generation as more financially attractive, but this is often finely balanced and any further rises in the price of diesel may make biomethane production for transport more attractive. There are many sewage treatment works and landfill sites where the gas produced exceeds the amount that can be used for electricity generation, which is often limited by the size of the grid connection. For many of these sites, cleaning the excess biogas and selling as transport fuel will be economically viable.

A variety of fleet operators are showing interest in the use of biomethane powered vehicles, due to the wide range of benefits. Four specific types of operator have been identified during the research for this report:

- For **HGV operators doing high mileage**, the payback time on vehicles can be as little as two years, due to their high fuel use. This is especially attractive to operators servicing customers in sectors such as food retail, who are now looking for their supply chains to make significant cuts in their CO_2 emissions.
- For **local authorities** the payback times on vehicles are usually longer, but for their fleets they have few other options for achieving their national and local policy targets for reducing CO_2 emissions and air pollution. This is a particularly attractive option for authorities that may be able to operate their own AD plant and thereby generate their own fuel.
- For **urban delivery fleets** payback times are also longer, but again the CO_2 saving and AQ benefits, as well as noise reduction, are compelling arguments.

- For **water companies and waste operators** the opportunity to use their own excess gas to fuel their own vehicles is attractive.

The biggest obstacle to the more widespread deployment of biomethane (or natural gas) powered vehicles is a lack of refuelling infrastructure and the high capital cost of installing it. The other obstacles of note are the lack of a competitive market in the provision of biomethane (there is currently only one major provider in the UK), the current set-up of incentives for renewables and a lack of certainty about their level in the future, and low values put on the residual value of gas powered vehicles at the end of their lease period.

For maximum impact, **our recommendation is that Government funding should be targeted at refuelling infrastructure, and gas upgrade equipment to expand the number of producers**. However, **we also recommend that at least some additional vehicle funding would help tip the balance and demonstrate the technology in a number of fleets where payback times are longer despite other benefits**.

Due to the tight timescale associated with the proposed demonstration, **we recommend that infrastructure funding should be provided through an additional call on the existing 'Infrastructure Grants Programme' (IGP)**. **Our research suggests that there are a number of existing organisations and consortia currently looking for funding assistance for this type of equipment, and that the speed with which the IGP could issue a new call would mean that this equipment could be provided within the time available**.

As the IGP cannot be used to fund vehicle costs, we suggest that funding for biomethane vehicles should be provided through a separate managed fund. This would either use the Environmental Protection state aid route, or should be provided as a separate category under the Green HGV programme which we are aware the Department is also considering. Although either of these options will take a little longer to set up than a new call on the IGP, the lead times for vehicles are shorter than for infrastructure, and in our opinion it would still be possible for vehicles to be ordered and purchased within the likely time available.

Finally, this report provides a number of suggested follow-up actions. Central to these is the provision of a clear government strategy, for the next 5-10 years, for the development of the use of gas in vehicles. This strategy needs to consider whether biomethane will continue to be delivered by tanker or make use of the gas grid, the level of subsidy set for various uses of biogas, the development of vehicle standards, and the facilitation of communication between gas producers and fleet operators.

Table of contents

Appendices

Terms and abbreviations used in this report

Term	Definition and notes
AD	Anaerobic Digestion, the breakdown of organic matter in the absence of oxygen. 'AD plant' refers to a purpose built facility where this process occurs for a specific feedstock, such as agricultural crop residues.
Biogas	Biogas is a general term for the 'raw' gas produced by the anaerobic digestion of organic matter, e.g. in landfills, sewage treatment or AD plant. It is typically 35-65% methane plus other gases and trace impurities.
BM	Biomethane – this is biogas that has been purified and concentrated, and consists of 95-98% methane.
CBM	Compressed Biomethane – this is biomethane that has been compressed, typically to 200-250 bar for use as a vehicle fuel.
LBM	Liquid Biomethane – this is biomethane that has been cooled and compressed so that it becomes a liquid, increasing its density and therefore facilitating transport and storage.
NG	Natural Gas – fossil gas, as supplied by the national gas grid in the UK, this is around 90% methane with some propane, butane and water vapour plus other trace gases.
CNG	Compressed Natural Gas - this is natural gas that has been compressed, typically to 200-250 bar for use as a vehicle fuel.
LNG	Liquid Natural Gas – this is natural gas that has been cooled and compressed so that it becomes a liquid, increasing its density and therefore facilitating transport and storage.
BM/NG	This abbreviation has been used in this report to denote 'either biomethane or natural gas', as in many applications they can be used interchangeably.
HGV	Heavy Goods Vehicle – used to denote goods vehicles of 7.5 tonnes gross vehicle weight and above
LCV	Light Commercial Vehicle – used to denote goods vehicles of gross vehicle weight under 7.5 tonnes
RCV	Refuse Collection Vehicle
HDV	Heavy Duty Vehicle – a general category that includes HGVs, RCVs and buses
Mpg	Miles per gallon – unit of vehicle fuel consumption still commonly in use
Pa	'per annum' – per year
Mt	Megatonne – 1,000,000 metric tonnes
CO_2e	'CO_2 equivalent' – a unit of greenhouse gas emissions, in which a mixture of gases (such as those emitted by a vehicle) may all be expressed in terms of the equivalent amount of CO_2 that would have the same potential to trap heat in the atmosphere
TTW	Tank To Wheel – a measure of gas emissions that only considers the emissions generated by burning a given amount of a specified fuel
WTW	Well To Wheel - a measure of gas emissions that considers all of the emissions generated by burning a given amount of a specified fuel, plus all of the emissions associated with producing that fuel and getting it to the vehicle

1 Introduction

This study has been produced by AEA in response to a Department for Transport (D*f*T) request for a 'Feasibility Study for a Road Vehicle Biomethane Demonstration Project', dated 3rd February 2010. Subject to the findings of this study, it is understood that the D*f*T intends to make £3.5 million available for the purchase of vehicles and equipment, to be drawn down in 2010 - 2011 financial year for a biomethane vehicle demonstration project.

In light of the need to reduce greenhouse gas (GHG) emissions from the road transport sector, biomethane is seen by many as a viable solution to the diversion of waste from landfill to anaerobic digestion (AD) plants, the use of a waste gas as a resource, the replacement of diesel with a non-fossil fuel and the increased security of supply. The proposed demonstration project is also expected to help the UK achieve a number of domestic and international climate change targets by 2050.

The aims of this study are:

- To help the D*f*T establish the potential for the use of biogas as a vehicle fuel;
- To identify the likely availability and interest of organisations to take part in a biomethane demonstration project in the UK;
- To make recommendations on any necessary adjustments to the proposed **structure** of the demonstration project;
- To make recommendations on key evaluation criteria to be included in a framework for assessing bids for the demonstration project;
- To provide clear recommendations on the format, nature and key success factors of the demonstration project.

Successful consortia bidding for funds from this demonstration project would receive grants for infrastructure and vehicles. These grants would cover the costs associated with mobile clean-up facilities, refuelling infrastructure and the marginal costs of biomethane-powered vehicles over and above conventional equivalent vehicles. The project scope will include city council owned/leased vehicles and Heavy Duty Vehicles (HDVs) including buses and Refuse Collection Vehicles (RCVs).

In order to achieve these aims, the authors carried out interviews with 43 different stakeholders in the industry, supported by desk-based research. The stakeholders interviewed included fuel providers, equipment providers, vehicle providers, fleet operators, local authorities, industry consultants, researchers and government agencies.

Chapter 2 outlines the key technologies involved in producing and using biomethane in HDVs. For each one the costs, technical maturity and production lead times are reviewed. Chapter 2 also provides an overall business case for the use of biomethane in HDVs, focussing on the cost savings and emissions reductions that it can achieve.

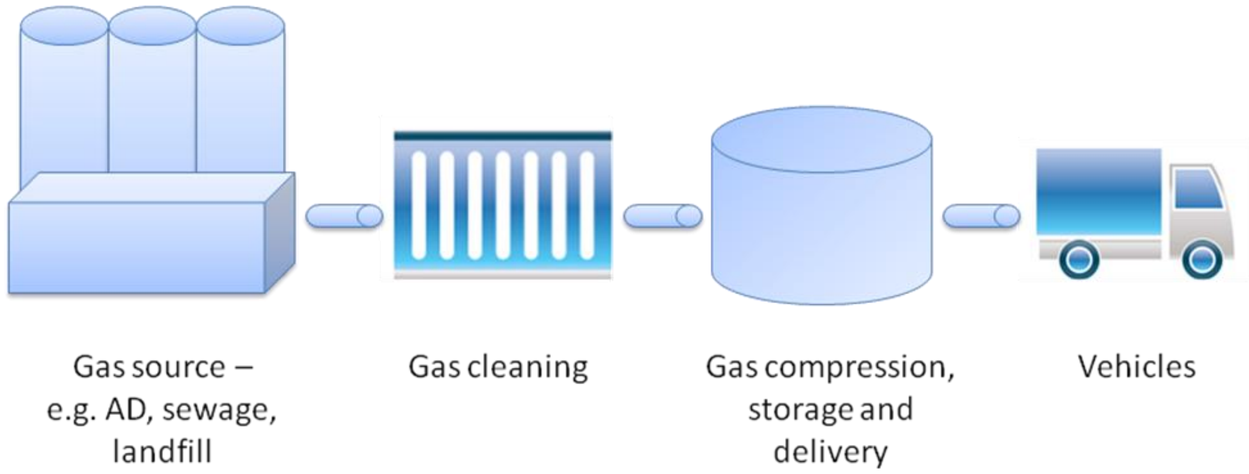
Chapter 3 is a short review of the viability of the proposed demonstration project. It comprises a brief analysis of how many organisations and consortia are already making plans to use biomethane vehicles, plus a review of the risks associated with the project and potential mitigation strategies.

Chapter 4 presents three possible options for the design of the grant scheme to support the proposed demonstration. It considers the funding routes that are available under state aid rules, the need to procure a management agent, and makes use of AEA's experience in running grant programmes to provide estimates of the minimum time that would be required to set up and manage the demonstration under different scenarios.

Finally, Chapter 5 provides a summary of the key areas to be considered in planning follow-up to the project.

1.1 Current status of the technology

At a basic level, the technology required to produce biomethane and then use it as a transport fuel can be divided into four key elements, illustrated below.



'Raw' biogas can be produced from a number of sources, using simple and mature technology. The available sources in the UK are examined in more detail below, but any new source will involve building works and require planning permission, and it is not expected that grant funding under the proposed programme would be used for this part of the process.

Raw biogas must be cleaned of impurities and the methane concentration increased before it can be used in vehicles. The cleaned, concentrated gas is typically 95-98% methane, and is referred to as biomethane (BM). There are a variety of technologies used to clean gas, at differing stages of development, and these are examined in more detail below. Clean up equipment would be installed at the site of a raw biogas source (e.g. a sewage works) and can be commissioned in a few months – it is expected that some of the funds made available under any demonstration project would be used for this equipment.

In order to fill a vehicle fuel tank with biomethane, or transport it to another site, it must first be compressed and/or liquefied. Although this uses no novel technology, if vehicles are to be refuelled quickly and in significant numbers, the scale and cost of this equipment is a significant part of the overall package. Equipment is required at both the site of biomethane production and the site of refuelling, and installation time varies from a day for a temporary filling station, to several months for larger, more permanent infrastructure. It is expected that this would be the most significant use of the funds made available under any demonstration project.

Like electric vehicles, hybrids and biodiesel, the technology to run vehicles on gas is very old but has only recently been redeveloped to modern standards. Vehicles using a spark ignition engine running on gas have been in widespread use around the world for many years, but have only recently been produced and offered for sale in the UK by major manufacturers. 'Dual fuel' vehicles using a compression ignition (diesel cycle) engine are being developed by UK companies and are now in commercial operation, offering strong advantages over spark ignition vehicles.

1.1.1 Biogas production

At the top level it is convenient to consider three main categories of biogas source – landfill sites, anaerobic digestion at sewage treatment plants and anaerobic digestion (AD) plants. AD plants can be further classified according to their feedstock, whether that be the Organic Fraction of Municipal Solid Waste (OFMSW or food waste), commercial food waste, agricultural crop wastes, manure and slurry, abattoir wastes and others.

Landfill gas is typically 30-60% methane, and this fraction changes over time, while sewage treatment and AD plants produce biogas at around 65% methane content. Landfill gas also has the highest levels of impurities, and therefore requires the most treatment, although all biogas cleanup equipment needs to be adjusted to cope with the particular composition of the biogas produced according to the particular feedstock used.

Landfill gas

UK landfills are the largest man-made source of methane emissions, accounting for about 3.2% of the country's greenhouse gas emissions in 2008 This high volume of gas originates from the local government reorganisations of the 1980s, when consolidation of waste disposal operations led to much larger landfill sites, and anaerobic conditions became established within the sites.

Tough environmental regulation was introduced in the 1990s, following fires, odour problems and even explosions on some sites. The 1993 Landfill Directive is particularly important, requiring the implementation of measures to reduce or eliminate the escape of pollutants, reducing the amount of biodegradable wastes that member states can landfill, setting targets for reduction based on 1995 levels, and banning the co-disposal of hazardous and liquid wastes.

The extraction and use of landfill gas is therefore a mature industry, driven largely by regulation rather than commercial considerations. The collection of the gas is very low cost, and most of it is currently used to generate electricity via burning in industrial generators at around 35% efficiency. Excess gas is flared, and in many cases this excess may be considerable if the electricity generation is limited by the size of the available grid connection.

Table 1: List of 30 largest landfill sites in the UK (out of a total of over 400), indicating flow rate of biogas produced, and installed generating capacity. (Source: John Baldwin, Renewable Energy Association UK Biogas Group, 2010)

Table 1: 30 largest landfill sites in the UK

Generating Station	Built	Company	Capacity	Approx biogas flow-rate in M3/hr	40 M3/hr as % of biogas flow-rate
ARPLEY LANDFILL SITE	01/03/2000	Infinis Limited	16,400	12,300	0.3%
CALVERT PHASE II	01/12/2002	Infinis Limited	13,728	10,296	0.4%
BROGBOROUGH PHASE III	01/02/2001	Infinis Limited	12,980	9,735	0.4%
L'FIELD STEWARTBY	01/08/1997	Infinis Limited	12,328	9,246	0.4%
PITSEA METHANE CONVERSION PLANT	01/10/2005	EDL (UK) LFG Generation Ltd	12,139	9,104	0.4%
RAINHAM PHASE II	01/04/2000	EDL (UK) LFG Generation Ltd	11,639	8,729	0.5%
Brogborough Phase V - A, C	01/07/2007	Infinis Limited	11,000	8,250	0.5%
Avondale Power Station - A	01/04/2004	Avondale Environmental Limited	10,227	7,670	0.5%
Roxby Gas to Energy - A, C, D	01/04/2004	Biffa Waste Services Ltd	8,520	6,390	0.6%
Packington Gas Control Plant - A	01/11/1987	Gastec Packington Partnership	8,250	6,188	0.6%
Hempsted Landfill	01/10/1996	Infinis (Re-Gen) Limited	8,242	6,182	0.6%
SHELFORD GENERATION PLANT II	01/12/2001	Brett Waste Management Ltd	8,048	6,036	0.7%
Mucking Landfill 2 - A	01/11/2001	EDL (UK) LFG Generation Ltd	7,789	5,842	0.7%
Cathkin RO Generation - A,C	01/04/2005	CLP Envirogas Limited	7,396	5,547	0.7%
SUTTON COURTNEY - NFFO5	01/10/2003	Infinis Limited	7,265	5,449	0.7%
Dunbar Power Plant, D	01/12/2004	Viridor Waste Disposal Ltd	7,000	5,250	0.8%
Mucking Landfill	01/11/1991	EDL (UK) LFG Generation Ltd	6,955	5,216	0.8%
Whites Pitt - A,C,D,E	01/04/1996	Canford Renewable Energy Ltd	6,916	5,187	0.8%
Lyme and Wood Power Plant - A	01/11/2005	Lyme and Wood Power Limited	6,200	4,650	0.9%
RISLEY 4 GAS TO ENERGY	01/04/1999	Biffa Waste Services Ltd	6,150	4,613	0.9%
Heathfield "A" Power Plant	01/08/1991	Viridor Waste Disposal Ltd	6,141	4,606	0.9%
SUTTON COURTENAY	01/03/1999	Infinis Limited	5,760	4,320	0.9%
Wapseys Wood Landfill (generation Phase 1)	01/07/1987	Infinis (Re-Gen) Limited	5,687	4,265	0.9%
North Foreshore Landfill Gas	24/08/2009	Belfast City Council	5,680	4,260	0.9%
Stoneyhill RO Generation - A,C	01/02/2005	CLP Envirogas Limited	5,325	3,994	1.0%
Trecatti 2 - A, C, D, E	01/10/2006	Biffa Waste Services Ltd	5,325	3,994	1.0%
Whitehead - A,D	01/09/2002	Viridor Waste Disposal Ltd	5,300	3,975	1.0%
Ockendon "A" Power Plant	01/11/1992	Viridor Waste Disposal Ltd	5,250	3,938	1.0%
HILL AND MOOR LANDFILL SITE	01/04/1999	Infinis (Re-Gen) Limited	5,072	3,804	1.1%
Garlaff Landfill Gas Project	29/12/2003	CLP Envirogas Limited	5,000	3,750	1.1%

GasRec, currently the only commercial producer of biomethane in the UK, operate at a landfill site owned by Sita at Albury. Electricity generation at the site was effectively limited by the capacity of the grid connection, and as installing a new substation was found to be uneconomic a significant proportion of gas was being flared. GasRec set up their biomethane plant at the site to use this excess gas, with a grant from the Infrastructure Grants Programme, and pay Sita a small royalty for the gas.

GasRec produce 5,000 tonnes per annum (tpa) of liquefied biomethane (LBM), enough to fuel 500 light commercial vehicles (LCVs) or 150 heavy goods vehicles (HGVs). Much of this gas is currently exported, with the remainder supplying all of the biomethane vehicle trial projects currently underway in the UK. The site is ideally situated for businesses operating within or near the M25, and has sufficient capacity to maintain this level of output for 15 years.

Sewage treatment

Anaerobic digestion is widely used in sewage treatment, primarily to produce a digestate which has low odour and is therefore more acceptable for spreading on land. Historically the gas has been flared, with increasing installation of electricity generation capacity in the last 20 years.

As for landfill gas, electricity generation at many sites will be effectively limited by the size of the grid connection, leading to a large excess of gas to be flared. This presents an ideal resource for use as transport fuel, and may be especially of interest to the water companies themselves for the operation of their own vehicle fleets.

Table 2 shows a list of 28 largest sewage treatment works in the UK, indicating flow rate of biogas produced, and installed generating capacity. (Source: John Baldwin, Renewable Energy Association UK Biogas Group, 2010)

Table 2: 28 of the largest sewage treatment works in the UK

Generating Station	Built	Company	Capacity kw	Approx biogas flow-rate in M3/hr	40 M3/hr as % of biogas flow-rate
Berryhill STW - A,C	01/01/1991	Wessex Water Services Ltd	900	450	9%
Blackburn CHP WTWW (6/07/07) - A, D	01/01/2007	United Utilities Water plc	1,151	576	7%
Bolton CHP at Bolton WWTW - A,C,D	01/04/1989	United Utilities Water plc	1,060	530	8%
Bury CHP at Bury WWTW - A,C,D	01/02/1990	United Utilities Water plc	1,864	932	4%
Davyhulme CHP at Davyhulme WWTW - A,C,D	01/02/1990	United Utilities Water plc	5,670	2,835	1%
Finham 2 STW - A,C,D	01/09/2004	Severn Trent Water Ltd	2,096	1,048	4%
Great Billing STW CHP Plant (RR) - A,B,C,D	01/01/1999	Anglian Water Services Ltd	1,000	500	8%
Hogsmill STW - A,D	01/06/1999	Thames Water Utilities Ltd	938	469	9%
Kings Lynn Wastewater Treatment Works	20/03/2008	Anglian Water Services Ltd	2,136	1,068	4%
Minworth Generating Station - C,D	01/01/2000	Severn Trent Water Ltd	9,500	4,750	1%
Nigg Bay WWTW - A,C,D	01/04/2002	Yorkshire Water Services Ltd	1,840	920	4%
Poole STW CHP Generation - A,C,D	01/01/2004	Wessex Water Services Ltd	1,395	698	6%
Reading (Island Road) - A,C, D	01/08/2004	Thames Water Utilities Ltd	3,422	1,711	2%
Roundhill STW Generating Station - A,C,D	01/06/2004	Severn Trent Water Ltd	1,048	524	8%
Ryemeads STW - A,D	01/01/1995	Thames Water Utilities Ltd	1,480	740	5%
Sandon Dock CHP at Liverpool WWTW - A,C,D	01/07/2002	United Utilities Water plc	1,938	969	4%
Seafield - A, C, D	01/04/2000	Veolia Water Outsourcing Limited	2,342	1,171	3%
Southern Water Budds Farm WTW	19/03/2008	Southern Water	1,741	871	5%
Southern Water Millbrook WTW	18/04/2008	Southern Water	1,112	556	7%
Stoke Bardolph STW Generating Station -C,D	01/05/1999	Severn Trent Water Ltd	4,742	2,371	2%
Strongford Sewage Treatment Works - A,C	01/12/2003	Severn Trent Water Ltd	2,096	1,048	4%
Wanlip STW	01/04/1999	Severn Trent Water Ltd	3,000	1,500	3%
Whitlingham STW CHP Plant - A,C,D	01/01/1995	Anglian Water Services Ltd	1,000	500	8%
Alfreton Sewage Treatment Works - A,C	01/06/2004	Severn Trent Water Ltd	860	430	9%
Esholt STW CHP	12/02/2009	Yorkshire Water Services Ltd	1,174	587	7%
Mitchell Laithes WWTC - A,C,D	01/11/1990	Yorkshire Water Services Ltd	1,309	655	6%
Derby Island STW Generating Station	24/01/2005	Severn Trent Water Ltd	1,962	981	4%
Netheridge 2 STW - A,C,D	01/03/2005	Severn Trent Water Ltd	836	418	10%
Hull WWTW CHPs	17/12/2008	Yorkshire Water Services Ltd	1,404	702	6%

Anaerobic digestion

Overall UK installation of AD plant has been historically low, due to the high capital cost of plant and poor overall returns on investment. However, a combination of government incentives for renewable energy, and rising gate fees for food and other wastes, has improved the economic case and stimulated a great deal of activity in the last few years.

Although widespread installation of AD plant is new to the UK, it is mature elsewhere in the world and the technology is well developed. Commissioning of new AD plants requires planning consent and typically takes several years from inception to operation.

Due to the current financial incentives (see section 2.2.2) most plant is designed to use the gas for combined heat and power (CHP). However, as with landfill and sewage plant, there are various reasons why AD plants may have excess gas that could be used as a transport fuel. In many cases AD plant will have a variable supply of feedstock, for example when a significant proportion of the feedstock comes from agriculture and varies seasonally. In such cases the highest return on investment is generated by sizing the CHP capacity to match the 'base load' of the plant, and then finding an alternative outlet for excess gas generated at peak load. Table 3 below contains a list of current and planned AD plants in the UK, together with biogas flow rates.

Table 3: Indicative list of current and planned AD plants in the UK – not exhaustive. (Source: John Baldwin, Renewable Energy Association UK Biogas Group)

Name	Owner	Location	Input tpa	Feedstock	Biogas Flow Rate m3/hour	CHP kWe	40 M3/hr as % of biogas flow-rate	Date completed
Siar	Lewis Council	Isle of Lewis	12,000	Food	180	400	22%	2007
Twinwoods	BiogenGreenfinch	Bedford	42,000	Food & Pig Slurry	580	1200	7%	2007
Kemble Farms	Colin Rank	Kemble	15,000	Cow slurry & crops	144	300	28%	2008
Biogask	Rennie & Sons	Turriff	12,000	Abattoir	180	400	22%	2007
Holsworthy	Summerleaze	Holsworthy, Somerset	40,000	Food	480	1200	8%	1998
Westwood	BiogenGreenfinch	Wellingborough	30,000	Food & Pig Slurry	484	1000	8%	2009
Cannington Cold Store	Tim Roe	Somerset	15,000	Food & crops	240	500	17%	2008
Tuquoy Farm	Crisenergy	Westray, Orkney	3,000	Food & cow slurry	48	100	83%	2008
Lowbrook Farm	Owen Yeatman	Blandford Forum	12,000	Cow slurry & crops	180	370	22%	2008
Bank Farm	Clive Pugh	Bishops Castle	12,000	Cow slurry	72	150	56%	2000
Green Tye	Guy & Wright	Much Hadham, Herts	13,000	Vegetable waste	170	350	24%	2008
Biocycle	BiogenGreenfinch	Ludlow	6,000	Food	92	190	43%	2007
Copys Green Farm	JF Temple	Wells, Norfolk	14,000	Slurry & crops	96	200	42%	2009
Crouchland Farm	Biogas Nord	Horsham, Dorset	30,000	Manure & Maize	504	1021	8%	2008
Mauri Products Ltd	Mauri Products Ltd	Hull	20,000	Baking wastes	411	850	10%	2008
Wanlip	Biffa	Leicester	40,000	Organics from MBT	700	1,434	6%	2005
Wilbert Farms	Hydro Leeming	Northampton	15,000	Food & crops	240	500	17%	2005
Woodhouse Nurseries	A Pearson	Alderley Edge, Cheshire	5000	Vegetable waste	50	100	80%	2008
Staples Vegetables	Staples Brothers Ltd	Boston	44,600	Vegetable waste & crop	500	1300	8%	2010
BV dairy	BV dairy	Shaftesbury		Trade effluent, product rinsings,UFP	220			2010
Langage Farm	Langage Farm							2010
OREL	Oxford Renewable Energy Limited	Chipping Norton						2010
Lower Reule	Lower Reule							2010
Branston	Branston	Licoln						2010
Gateshead MBT AD	Graphite Resources	Gateshead	160,000	MBT Fibre	700			2010
GWE Biogas	GWE Biogas	Driffield	50,000		500			2010
Adnams Brewery	Bio-Group	Southwold						

As can be seen above, AD plants vary considerably in size. A recent Carbon Trust report[1] states that a food waste AD plant processing around 25,000 tonnes per annum is 'typical' for an AD plant. This would represent the food waste from around 70,000 households. Several of the stakeholders interviewed identified this size of plant as common, although some much larger plants are in development and there are also many much smaller agricultural plants.

1.1.2 Gas cleaning

There are currently three main gas cleaning technologies in widespread use

1. water scrubbing,
2. chemical absorption and
3. pressure swing adsorption (PSA).

Two promising further technologies, cryogenic upgrading and membrane separation, are in development but are currently expensive and unproven in the field.

[1] 'Biogas from Anaerobic Digestion', Carbon Trust, 1st April 2010, available at www.carbontrust.co.uk

Water scrubbing

This is generally the lowest cost technology for larger plants where there are suitable economies of scale. It requires towers 14m high, which may require planning permission, and these towers can also recover some heat. The technology recovers 99% of methane with 1% being vented to the atmosphere, and also removes H_2S and siloxanes.

Chemical absorption

This approach recovers 99.5% of the methane in the biogas, venting <0.5%. However it does require significant process heat, making it ideal where waste heat is available, such as may be the case at a site which also has a CHP unit that is not fully utilised. If heat is not available, 15-20% of the biogas supply is required to produce it. Some stakeholders identified a possible risk of gas contamination when using this technology.

Pressure Swing Adsorption (PSA)

This approach only concentrates 92% of the methane in the biogas, with the remaining 8% being siphoned off with the extracted CO_2. The 8% fraction can be burned but will need to be concentrated back up to around 30% methane to do so. However, the process does not vent any methane direct to the atmosphere. PSA technology also has the advantage of having a very small footprint.

The choice of technology will vary from site to site depending on the characteristics of the gas, volume of gas to be cleaned and the intended use. Lead times will depend on the type of equipment and the size of the installation, but are much shorter than for AD plant – typically 3-6 months. A number of stakeholders suggested that the installation of clean up equipment was very straightforward, but one consultant sounded a note of caution that equipment would need to be calibrated carefully to the individual gas profile of each site, and that this could cause delays.

Some projects are seeking to bring in portable clean-up kit based on chemical absorption. This arrives in an articulated trailer, and includes a compressor, so biogas goes in one end and compressed biomethane (CBM) comes out of the other ready for use in vehicles. This equipment costs £12,000 per month to lease and provides an opportunity for vehicle trials using a wide variety of potential BM sources.

1.1.3 Gas compression, storage and delivery

The handling and storage of methane, either biomethane or natural gas, is a mature technology with a wide variety of companies providing off-the-peg solutions.

Biomethane can either be stored and moved as compressed gas (i.e. Compressed Biomethane (CBM) or liquified gas (i.e. Liquified Biomethane (LBM). CBM, like Compressed Natural Gas (CNG), is relatively cheap and easy to store and handle, but it has a low energy density making it hard to transport in large quantities. LBM and Liquefied Natural Gas (LNG) are much denser – a single road tanker can transport 20 tonnes of LBM, but only 6 tonnes of CBM. However, it must be kept cold, meaning that those working with it must wear protective gloves and other clothing, and as some methane boils off vapour pressure builds up in the tanks and must be vented. More energy is also required to liquefy the gas versus compression, offset to an extent by the reduced energy needed to transport the liquefied gas.

In practice the choice to use liquefied or compressed gas will depend on the individual requirements of each operation. As the only supplier of biomethane currently in operation in the UK, GasRec liquefy their gas so that it can be transported easily to a variety of UK and international customers by tanker. Fleet operators running vehicles over long distances are also likely to choose liquefied gas to provide the required vehicle range. More localised operations are likely to choose the cheaper option of compressed gas, and if natural gas is used this could simply mean running gas from a gas main through a compressor at their site.

The cost of storage and refuelling facilities depends on the storage capacity required and the speed with which vehicles must be filled. At minimum, a small compressor connected to the mains gas supply will 'trickle fill' a light vehicle overnight, and costs about £7,000. At the other end of the scale a large station which can service dozens of vehicles and fill each in around the same time as it takes to fill with diesel will cost around £500,000. The minimum amount quoted by stakeholders for a permanent facility servicing commercial vehicles was around £150,000, and the cost of filling infrastructure does benefit from economies of scale, so shared infrastructure is financially beneficial.

Chive Fuels operates the only network of publicly accessible gas filling stations in the UK. They and a number of other companies can also provide temporary mobile filling stations at any site, which are refilled by trucks delivering liquefied gas. A number of stakeholders interviewed, such as Leeds City Council, are currently making use of this type of facility for existing vehicle trials.

The lead time for a mobile filling station is very short, under one month. More permanent installations will require more time, although most equipment suppliers suggested that the equipment could be provided well within the six month window likely to be required under the proposed demonstration programme. The longest lead time quoted was East Midlands Airport, whose fuelling infrastructure they estimate will require 6-10 months to commission.

Table 4 below gives an indication of the number of vehicles and filling stations in operation around the world. It is included here particularly to illustrate the point that light duty vehicles (LDVs) generally require more widespread filling infrastructure than heavy duty vehicles (HDVs). In the current UK context, biomethane seems to offer the largest cost and environmental benefits to HGV operators, and this indicates that a reasonably large fleet of such vehicles could be supported by a relatively modest refuelling infrastructure.

Table 4: Deployment of natural gas vehicles and filling stations around the world. (Source: European Natural Gas Vehicle Association, via presentation given by Cenex.)

Country	Total	Light duty	Buses	HGVs	Stations
Argentina	1,663,340	1,663,340			1,713
Pakistan	1,600,000	1,599,960	40		1,847
Brazil	1,476,219	1,476,219			1,561
Iran	611,516	608,863	2,641	12	347
Italy	432,900	430,000	2,100	800	609
India	327,915	315,200	12,000	715	198
China	118,353	81,257	36,996	100	486
Russia	61,000	18,000	8,000	35,000	219
Germany	59,500	58,000	1,500		720
USA	50,000	36,000	11,000	3,000	1,600
Sweden	14,536	13,407	760	369	115
France	10,150	7,500	2,000	650	125
Canada	9,740	9,500	240	0	101
Switzerland	5,830	5,638	138	54	97
Spain	1,493	122	760	611	35
Australia	1,370	10	1,258	102	146
Austria	1,022	1,020		2	98
United Kingdom	448	101	14	333	19
Sub total	*6,445,332*	*6,324,137*	*79,447*	*41,748*	*10,036*
Rest of the world	*851,263*	*672,827*	*85,533*	*92,903*	*2,247*
Total	**7,296,595**	**6,996,964**	**164,980**	**134,651**	**12,283**

Source: European Natural Gas Vehicle Association

1.1.4 Vehicles

As shown in Table 4 above, vehicles running on methane are already widely deployed around the world. There are essentially two different vehicle technologies, as for conventional vehicles, one based on spark ignition and one on compression ignition.

A conventional spark ignition petrol engine will run on natural gas with only minimal modifications, and this is usually referred to as a 'dedicated' gas engine. Some vehicles with this type of engine retain a small petrol tank, and can switch to running on petrol if they run out of gas – these are referred to as 'bi-fuel' engines.

Conventional compression ignition diesel engines are more efficient than spark ignition engines, but these will not work with only gas in the cylinders. One way around this problem is to introduce both diesel and gas into the cylinders, which allows the diesel to ignite under compression, thus also igniting the gas. These are referred to as 'dual fuel' engines.

More detail on both vehicle types is given below.

As for gas distribution, both compressed gas, CNG/CBM, and liquefied gas, LNG/LBM, can be used to store gas in either type of vehicle. Compressed gas does not have to be cooled, can be stored indefinitely and is cheaper than liquefied gas. However, liquefied gas has greater energy density, and so allows greater vehicle range, although it is more expensive (an extra ~£10,000 per vehicle). Liquefied gas will also steadily evaporate within its tanks, leading to a build up of vapour pressure – therefore in practice the fuel must be used within 24-48 hours of refuelling and so this technology is only suitable to commercial vehicles in constant use. At the moment, there are established regulations for the use of CNG/CBM in vehicles, but not for LNG/LBM.

All gas vehicle types require qualified support and maintenance staff, and the training of staff is one additional cost that needs to be factored into their use.

'Dedicated' vehicles

Of the 11 million or so vehicles running on natural gas around the world, most run on a conventional petrol engine that has been re-tuned. It is relatively simple to convert a vehicle in this way, and in locations where refuelling infrastructure is available, and gas is cheap, it is an attractive option.

Due to the similar behaviour of NG/BM and petrol vapour within an internal combustion engine, vehicles can also be set up to run on both – so-called 'bi-fuel' engines. These are popular in those applications where range is a problem, and can be designed with a smaller gas storage capacity because if the vehicle runs out of gas it can switch to petrol. Since the majority of the extra cost and weight of a gas vehicle arises from the gas tanks, this is doubly attractive.

Bi-fuel engines do have a drawback. In theory, a spark ignition engine powered by gas can be more efficient than a similar engine running on petrol because gas is a higher octane fuel. In practice, converted petrol engines and bi-fuel engines fail to fully take advantage of this efficiency, which is one reason why in recent years more manufacturers have been developing gas engines that are designed from scratch for gas. In the last two years Mercedes have launched completely redesigned gas versions of the Sprinter LCV and the Econic HGV, and Iveco also have a range of dedicated gas versions of their vehicles now available.

No manufacturers in Europe offer dedicated gas variants of the largest goods vehicles, because they still cannot compete with modern diesel engines for efficiency. The Mercedes Econic has a 280 bhp engine, and in interview a representative of Mercedes said that this was the largest engine likely to be produced in a dedicated gas variant.

Dedicated gas engines are used in buses, as they are not as heavily loaded as HGV engines. The Natural Gas Vehicle Association of America reports that 27% of all new buses ordered in the US last year were gas variants, and bus manufacturer Optare, based in Leeds, has been shipping gas powered buses to the US for several years.

'Dual fuel' vehicles

Dual fuel engines have been used in industrial applications since the 1930s, but their development for use in vehicles is relatively recent. They retain the benefits of diesel engines over spark ignition engines – higher efficiency, greater power density and lower maintenance – while offering the cost savings, emissions and noise reduction of using gas. They can also switch seamlessly to running on 100% diesel if the gas tanks are exhausted, removing the 'range anxiety' associated with a dedicated gas vehicle.

The technical challenge of dual fuel is to introduce as much gas as possible into the fuel mix while maintaining the required level of engine performance. While the vehicle is in use, the engine control unit will adjust the balance of diesel and gas to deliver the required power. In general, it is possible to achieve a gas substitution rate of 60-80% when the engine is under its full load, but this falls when the vehicle operates on a more varied drive-cycle.

One fleet operator interviewed was able to achieve a 60% gas substitution rate running articulated 44t trucks with a dual fuel conversion. This was averaged over a mixture of 'trunking and shunting' operations, i.e. both long and short distance, and the substitution rate was >60% for the trunking. On the other hand, another stakeholder trialling a refuse collection vehicle with a dual fuel conversion got almost no gas substitution at all.

Our interviews identified three main providers of dual fuel technology – Hardstaff Group, Clean Air Power and Volvo. Both Hardstaff and Clean Air Power provide conversion of specific vehicle models, which have been developed in conjunction with the manufacturer so that they do not invalidate lease terms and warranties. Conversions of the Mercedes Actros and Axor were the models that were mentioned most by fleet operators interviewed for this study, with Hardstaff having sold around 60 Actros or Axor conversions. Volvo and DAF trucks have also been converted.

Clean Air Power are aiming to integrate their dual fuel system fully within an OEM vehicle, and are working with Volvo to achieve this. The result will be an off-the-line Volvo-branded truck, due for sale in 2011, with the dual fuel systems fully integrated into the engine control systems. When interviewed, Clean Air Power and Volvo both expressed the view that this higher degree of integration would result in greater gas substitution and higher efficiency than any of the converted vehicles currently in use. Several of the fleet operators interviewed are aware that this truck is being developed, and are eagerly awaiting its launch to see if it can deliver the promised performance. Mercedes are also reported to be working on their own dual fuel vehicle, but on interview declined to comment.

Manufacturers of dual fuel vehicles claim lower maintenance costs due to cleaner engine parts and fewer oil changes. In practice there will be a learning curve for maintenance, which will have to be overcome before this benefit is properly realised.

Further stakeholder views on vehicle technology

One stakeholder interviewed was a major global logistics company. As a household name they have ambitious carbon reduction targets and their fleet accounts for 85-90% of their total emissions. They are concerned about the possible negative publicity attached to the use of biofuels, and have seriously explored the gas option, testing vehicles on LPG, CNG and LNG.

Their experience confirms the conclusions drawn by other interviewees. They found dedicated or bi-fuel CNG/CBM engines were not efficient enough for HDVs, although they could be good for urban deliveries. Early development dual fuel engines showed great promise, but in practice only achieved 40-45% gas substitution and had some reliability issues.

Ultimately they took the view that dual fuel technology is developing rapidly, and in combination with BM rather than NG the carbon savings are impressive. They are eagerly awaiting the fully integrated dual fuel engine from Volvo, and are proceeding with plans to introduce 20 trucks, 26t and 35t, operating out of a London base. Table 5 provides a list of gas powered vehicles available together with the typical price premium and lead time.

Table 5: Gas powered vehicles available (or soon to be available) in the UK. (Source: John Baldwin, supplemented with stakeholder interviews and estimates from Cenex.)

Vehicle Type	Typical price premium	Vehicle	Engine/fuel	Status/lead time
Cars and small vans	~£1,000	VW Passat TSI Ecofuel	Bi-fuel	On sale
		VW Caddy Maxi Ecofuel 7 seater	Bi-fuel	On sale/12 wk
		Volkswagen Caddy Ecofuel	Bi-fuel	On sale/12 wk
		Volkswagen Caddy Maxi Ecofuel	Bi-fuel	On sale/12 wk
Medium/large vans	~£3,000 – 5,000	Mercedes Sprinter NGT	Bi-fuel	On sale
		Iveco Daily CNG	Dedicated/ Bi-fuel	On sale
Medium rigid trucks (11–26t)	£21,000 – 23,000	Iveco Eurocargo CNG 12t/16t Iveco Stralis CNG 18t	Dedicated	On sale
		Mercedes Econic CNG	Dedicated	On sale/3 mth
Articulated heavy trucks (28t +)	£20,000 – 25,000	Mercedes Econic CNG	Dedicated	On sale/3 mth
		Hardstaff Group conversion of Mercedes Benz (DAF vehicle also under investigation)	Dual fuel	On sale/3+1 mth[2]
		Clean Air Power conversion of Volvo or Mercedes	Dual fuel	On sale/3+1 mth
		Fully integrated Volvo using Clean Air Power technology	Dual fuel	In dvmt (Est 2011)
Refuse trucks	£20,000 – 25,000	Mercedes Econic CNG	Dedicated	On sale
		Dennis Eagle (still developing)	Dual fuel	On sale/4 mth
		Iveco Stralis	Dedicated	Likely for Q4 2009
12 - 15 seater mini-bus	~£3,000 – 5,000	Mercedes Sprinter NGT – on trial in UK	Bi-fuel	On sale
Buses	£13,000 – 18,000	Foton CNG Hybrid Bus (OEM)	Dedicated	1st Qtr 2010
		Cummins Westport Re-engine Trident 2	Dedicated	On sale
		Optare with Hardstaff conversion	Dual fuel	In dvmt
		Diesel/Natural Gas Hybrid-Dennis Enviro	Dual fuel	In dvmt (Est 1st Qtr 2011)

[2] This indicates a three month lead time for the vehicle from Mercedes, plus around one month (often less) for the conversion.

2 The business case

2.1 Potential benefits to the UK

The main benefits to the UK of using biogas to fuel vehicles are the potential cost savings to the transport sector, and the CO_2e savings to the UK as a whole. There are also a range of additional benefits, notably:

- Air quality improvement
- Security of energy supply
- Noise reduction
- Diversion of waste from landfill
- Job creation
- Development of export business

2.1.1 Potential financial savings

Financial savings need to be considered from the point of view of both the biogas producer and the vehicle operator.

Gas producers

In most cases biogas producers currently find that using this gas to generate electricity offers a better rate of return than producing biomethane from biogas for use in transport. However, as diesel prices rise this situation may change and a recent Carbon Trust report[3] suggested that transport fuel has the potential to offer a higher return than other uses of biomethane. There are several reasons why the industry may not adapt quickly to this idea, especially the absence of a significant fleet of vehicles to use the fuel.

In practice, competition with electricity production may be unimportant in the short term. There are many sites across the UK were biogas is used to create electricity. Some of these are operating at full capacity, and they have excess gas which is simply flared. This excess gas could be used for a demonstration project without having any impact on the normal site operations (further details are provided below). In many of these cases, producing biomethane for transport is likely to provide a good rate of return from biogas that would otherwise be unused. There are also many opportunities for fleet operators to produce their own gas to fuel their own fleets (e.g. local authorities, waste management companies). These sources are likely to be more than adequate to support the initial development of a UK biomethane vehicle fleet.

Vehicle operators

Based on the information collected in this study and under current price conditions, some fleets running vehicles on biomethane are already operating in a cost effective manner when considering fuel price savings alone. For a variety of other fleets using biomethane will incur some additional cost, but provide a range of benefits – carbon savings, air quality emissions savings and noise reduction – that would be difficult and/or costly to achieve by other means. Overall, the number of operators for whom biomethane is financially worth considering is significant, and will only increase if the price of diesel rises relative to the price of biomethane.

Our findings in this report are unusual, if not unique, in being based on real operator data. In preparing this report a wide range of fuel saving estimates were reviewed. Most are based on the assumption of energy equivalence – i.e. that the fuel consumption of a gas powered vehicle will be the same as for an equivalent diesel vehicle in terms of the joules of energy consumed. This is a reasonable starting assumption, as the engine technology is essentially the same. In fact from a theoretical engineering

[3] 'Biogas from Anearobic Digestion', Carbon Trust, 1st April 2010, available at www.carbontrust.co.uk

point of view one would expect a gas vehicle to be marginally more efficient due to the higher octane rating of the fuel allowing higher combustion pressure.

We were able to obtain basic fuel efficiency figures for two types of vehicle during the course of our stakeholder interviews. The first were 44t HGVs powered by a diesel engine converted to 'dual fuel'. The second was a spark ignition dedicated gas powered refuse collection vehicle. In both cases the operator was also running an almost identical diesel equivalent vehicle side by side. Both vehicle types are considered in more detail below.

Vehicle 1: Dual-fuel HGV

The 44t duel-fuel HGVs used by the operator consulted in this study were used for a mixture of long and short haul journeys, and achieved an average of 60% substitution of gas for diesel. This translates to a fuel saving of 11p per mile as compared to identical diesel-only vehicles running on the same routes. Given that the vehicles are in constant use and travel around 130,000 miles per annum, this gives an annual saving in the region of £14,000.

The conversion cost for regular diesel HGVs to duel-fuel HGVs is approximately £25,000, with a payback for the vehicle alone under two years. However, the operator also spent £300,000 on a filling station, and plans to expand both its dual-fuel fleet and its filling station network.

In terms of energy use per mile [or per km], the vehicles were actually around 4% less efficient (although they still save CO_2). This suggests that as the engines are further tested and developed, further savings may be possible. We also spoke to a second operator of similar vehicles, who also estimated their payback time for the vehicle conversion at around two years, and this was the figure also quoted by the manufacturers we spoke to (assuming annual mileage of 100,000+ miles).

A third operator we consulted was operating similar dual fuel HGVs, but achieved less promising results, with a gas substitution rate of around 45%. This may have been due to the technology itself, the particular drive cycle the vehicles were undertaking, or a combination of both these and other factors. This example highlights the fact that while good results have already been achieved in practice, they are by no means guaranteed, and if vehicles are being 'demonstrated' rather than 'trialled' then the operations must be carefully chosen.

Vehicle 2: Spark-ignition dedicated Refuse Collection Vehicles (RCV)

We spoke to a local authority running diesel RCVs and achieving fuel consumption of around 3.3 miles per gallon (mpg) or 1.17 km/litre. They introduced a CNG variant of the same vehicle, which achieved 1.32 km/kg gas, which equates to a financial saving of around 20p per km. On the basis of the vehicle mileage this translates to a saving of just under £4,000 pa by our calculation, although the interviewee estimated that they would save closer to £5,000. The cost differential on this vehicle is £21,000 - £23,000 compared to the diesel equivalent.

In this case the cost of refuelling infrastructure is a real stumbling block, although the council is keen to further pursue the use of biomethane in its RCV fleet. Like the majority of local authorities, carbon saving and air quality are concerns, and noise reduction is of particular benefit in an RCV fleet.

From an energy use point of view the gas powered vehicle was less efficient than its diesel equivalent. In this case the drop in efficiency was 27%, which is largely due to the fact that spark ignition engines are inherently less efficient than compression ignition engines.

Greenwich study

Cenex[4] carried out a fleet biomethane study for Greenwich Borough Council in July 2009. The scenario under consideration was that Greenwich would construct its own AD plant, taking 20,000 tonnes per annum of organic waste – 53% Organic Fraction of Municipal Solid Waste (OFMSW) and 47% garden waste. The study reviewed the composition of the council vehicle fleet, and analysed the costs and benefits of converting all or part of the fleet to run on biomethane, versus using the biogas produced to generate electricity.

[4] The UK Centre of Excellence for Low Carbon and Fuel Cell Research www.cenex.co.uk

The study conclusions are a good illustration of the position in the UK economy as a whole. The 20,000 tonne facility would produce enough biomethane to run 35 of the council's 38 RCVs, displacing 457,824 litres of diesel and saving 3,293 tCO_2e per annum (pa). The financial benefit to the council would be a fuel saving of £166,484 to £303,831 pa based on diesel price of 85 pence per litre (ppl) to 115 ppl. However, the revenue from using the gas for electricity production would be £376,311.

Thus it can be seen that as a fleet operator, Greenwhich could save money by converting its fleet, but as a biogas producer, it could make more money by generating electricity. As a London borough council, Greenwich has particular pressures to reduce the noise and air quality emissions of its heavy vehicles, as well as reduce its carbon footprint. Given that its other options for achieving these goals are limited and very expensive (e.g. purchasing hybrid or electric vehicles) the extra revenue from electricity generation may well be deemed worth foregoing in order to achieve these goals.

2.1.2 Potential CO_2 savings

The chemical composition of methane (CH_4) means it has the lowest direct CO_2 emissions per unit of energy of any hydrocarbons. For this reason, running vehicles on either natural gas (i.e. fossil methane) or biomethane offers the promise of substantial CO_2e emissions savings. These direct 'tank-to-wheel' (TTW)[5] savings are similar for natural gas and biomethane.

Running vehicles on biomethane also offers a substantial additional benefit on a 'well-to-wheel' (WTW)[6] basis. This is not only because biomethane comes from renewable feedstocks, but also because methane is a greenhouse gas with over 20 times as much ability to trap heat in the atmosphere as CO_2. Some sources, including the latest CONCAWE report[7], state that when estimating CO_2 savings, biomethane used in vehicles has a positive environmental impact as it would otherwise be directly released or flared to the atmosphere.

Of course in practice, in the UK, it is unlikely that much of the biogas used to create biomethane would have been allowed to vent to the atmosphere. Landfill sites and sewage treatment works are now regulated so that any excess gas is at least flared, if not used for electricity generation or CHP. However, some organic wastes that are currently allowed to decompose and vent methane to the atmosphere will in future be used in AD plants. In these cases the avoided methane emissions would result in very significant net savings in CO_2 equivalent emissions (CO_2e).

Supply side estimate of carbon emissions abatement potential

A recent Carbon Trust report attempts a 'supply side' estimate of the potential carbon savings from using biomethane for various purposes. This analysis is sensitive to the different levels of 'avoided methane emissions' for different feedstocks, as can be seen in Table 6 below – for example there are no avoided methane emissions for sewage sludge because these are all currently either used or flared anyway, but for AD it is assumed that methane emissions are avoided.

[5] Tank to Wheel (TTW) is a term used in Life Cycle Assessment and refers to the various stages from the use of fuel onboard a vehicle (tank) through to the disposal and recycling of a vehicle (wheel).
[6] Well to Wheel (WTW) is a term used in Life Cycle Assessment and refers to all stages in the life cycle of a fuel and vehicle.
[7] http://ies.jrc.ec.europa.eu/WTW

Table 6: Estimated carbon savings based on figures given in 'Biogas from Anearobic Digestion', Carbon Trust 2010

Feedstock		Sewage	Manure/Slurry/ Agricultural residue	Food waste
Total waste arisings	Mtpa	15[8]	32[9]	18
% Total assumed accessible for AD	%	90%	50%	40%
Waste processed in AD plants	Mtpa	13.5	16	7.2
CO_2 saving from using biogas for transport	Mtpa	0.32	0.92	0.71
CH_4 avoided	Mtpa CO_2e	0	1.07	0.76

The total CO_2e saving including avoided methane from using all available biogas for transport would be around 3.78 (Mt)CO_2e pa. This is the summation of all CO_2 savings and CH_4 avoided from using biogas for transport as can be seen in Table 6 above. This provides an upper bound on the potential saving from the supply side.

Demand side estimate of carbon saving potential

Various estimates of carbon emissions saving are given for gas powered vehicles, either fuelled by gas only or dual fuel. As outlined above, we have been able to ascertain basic operating data from two of the stakeholders interviewed in this study which we can compare with the claims made by vehicle manufacturers and other interested parties.

For vehicles running purely on Compressed Natural Gas (CNG) with spark ignition engines, a saving of 20% CO_2e on a diesel equivalent is typically claimed. It is further claimed that when the vehicle is running on biomethane it is 'carbon neutral' or zero emissions.

In practice, the one vehicle for which we were able to obtain data suggests lower savings, albeit still impressive. When run on CNG we would estimate the WTW saving at around 7% in practice. Run on biomethane that increases to 65%. These figures are calculated using the lifecycle emission factors provided in the forthcoming 2010 update to the Defra/DECC GHG Conversion Factors for Company Reporting, given in Table 7 below.

Table 7: Defra lifecycle emissions factors for diesel, CNG and biomethane (provided in GJ for comparability)

Fuel	Unit	$kgCO_2e$ per unit	% of diesel factor
Diesel	GJ	88.946	100%
Compressed natural gas (CNG)	GJ	67.832	76%
Biomethane	GJ	27.106	30%

Source: Forthcoming 2010 update to the Defra/DECC GHG Conversion Factors for Company Reporting (produced for DECC by AEA)
Notes: Figures for biomethane are based on reporting from the Renewable Fuels Agency (RFA) on the average figures for biomethane currently supplied to the UK market.

There are several possible reasons for the discrepancies. The estimates may be optimistic, based on a theoretical fuel consumption based on energy content, or assuming a base case that uses a more

[8] This figure, used by the Carbon Trust, comes from work by Earnst and Young for National Grid. Recent work by AEA used a Defra figure of 1.73 Mtpa. ('Analysis of Renewables Growth to 2020', report to DECC by AEA, March 2010).
[9] Total agricultural residues are much higher than this figure, probably closer to 90 Mtpa. However, much of this is dry material, only suitable for AD if mixed with wet material such as slurry. Thus the Carbon Trust provide the quoted figure as that which is suitable for AD.

advantageous reference system for the production of biomethane. The observed performance may have been inaccurately measured, or the sample of one vehicle may simply be unrepresentative. Either way, further trials and demonstrations will provide the opportunity to gather more data and provide a more reliable assessment of the benefits.

In the case of dual fuel vehicles, the vehicles for which we were given data would save 13% of CO_2e when running on CNG, or 41% running on CBM. The emission savings for dual fuel vehicles are very sensitive to the level of gas substitution achieved, and the best results are achieved when the vehicles are used for longer hauls (as the engine performs better under heavy continuous load).

Given the potential financial savings, it seems likely that take up of biomethane as a fuel will be greatest for heavy duty vehicles doing high mileages. In terms of achieving the greatest carbon savings, this is good news – these are the key target group of vehicles in the freight sector, as they currently account for the highest proportion of goods moved in the UK. The following statistics from the DfT's 'Road Freight Statistics 2008' illustrate the point:

- There are currently around 100,000 vehicles over 33t registered in the UK, most over 40t:
- These vehicles account for 47% of freight vehicle km, and 74% of goods moved (tonne km):
- 71% of goods moved are transported on hauls of over 100km:
- Articulated vehicles over 33t achieve an average fuel efficiency of 8mpg or 34.9 lt/100km:
- 2008 was the first year in which enough natural gas powered freight vehicles were registered for them to appear in the statistics – 100 were registered.

There are relatively few technical options for reducing carbon emissions from heavy goods vehicles of this type. The GHG emissions from HGVs in 2008 were 23.8 $MtCO_2e$ (from the UK Greenhouse Gas Inventory[10]), representing 18% of total domestic transport emissions (compared to 15.8 $MtCO_2e$, 12% respectively for light goods vehicles). The Committee on Climate Change's 'extended ambition scenario' modelled a range of non-power-train HGV technologies (e.g. improved aerodynamics) plus limited uptake of hybrid trucks, and these gave a combined CO_2e saving of only 1 Million tonnes CO_2e per annum ($MtCO_2e$ pa) by 2020 – across all goods vehicles, not just the heaviest. Certainly no other technology offers anything close to the 41% saving per vehicle km that is currently being achieved by some of the vehicles identified in this study.

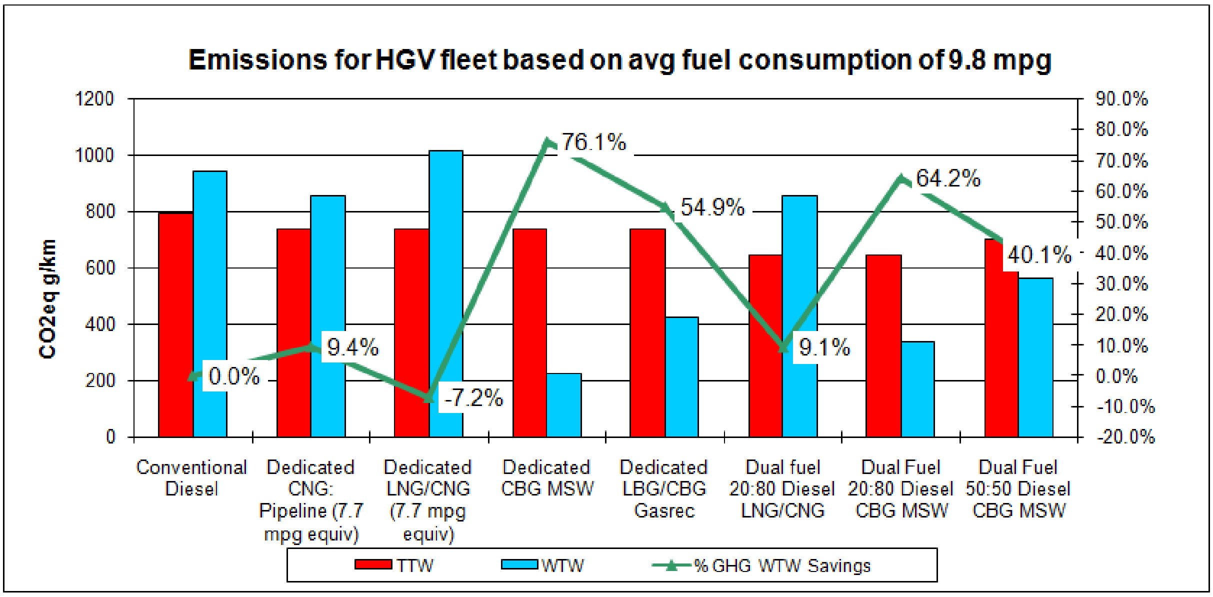
It is outside the scope of this report to provide a detailed uptake scenario and carbon saving estimates for the use of biomethane in vehicles. However, a quick 'back-of-an-envelope' calculation is useful in illustrating why further investigation and demonstration in this area is worthwhile.

If one assumes no further advance in the technology, that 10% of the 100,000 articulated vehicles over 33t might run on dual fuel, and that of these, 50% use CBM and 50% use CNG, this would equate to a carbon saving of 0.3$MtCO_2e$ pa. Based on the numbers of filling stations and gas-powered trucks elsewhere in the world, this would not require a network of more than around 100 filling stations (albeit large ones) and the amount of biomethane required would be well within the current resource as estimated above.

As discussed, these numbers are only based on a very small sample of vehicles, but they compare well to other work on trialling biomethane vehicles in Camden by Cenex, see Figure 1 below. The x axis shows the number of vehicles tested and the y axis shows the CO_2e g/km and the % addition or reduction in CO_2e compared to the conventional diesel. Note the WTW emissions savings for the dual fuel vehicles to the right. The 20:80 Gas/Diesel using Compressed Biogas achieved a 64.2% CO_2e saving and the 50:50 Gas/Diesel Compressed Biogas HGV achieved a 40.1% CO_2e saving

[10] Summary data tables on the UK Greenhouse Gas Inventory for 2008 are available from DECC's website at: http://www.decc.gov.uk/en/content/cms/statistics/climate_change/gg_emissions/uk_emissions/2008_final/2008_final.aspx

Figure 1: Camden biomethane trials by Cenex



Sources: Emission data from CONCAWE, Gasrec analysis from CENEX Camden biomethane study

2.1.3 Additional benefits

Air quality

This has been an historical driver of gas engine technology. One of the companies currently developing dual fuel technology in the UK (Clean Air Power) originally started its engine development for Caterpillar in the US, in an effort to produce engines which would meet the stringent Californian air quality standards.

Various figures are given for AQ emissions, but all substantially lower than for diesel. As an example, the Mercedes Econic running on CNG claims ‘virtually zero’ particulate matter, and easily meets the European EEV standard for other emissions.

Almost all vehicles running on gas achieve Euro V, Euro VI or EEV emission standards. Meeting ever more stringent emissions standards with diesel engines incurs steadily increasing costs (and some loss of engine efficiency) which will make natural gas and biomethane vehicles more financially attractive where these standards are required, as will be the case in the London Low Emission Zone.

Security of supply

The use of biomethane potentially presents fleet operators with the chance to limit their exposure to fossil fuel price fluctuations. While the prices of oil and gas are subject to global fluctuations in supply and demand, the UK biogas resource is a domestic source of energy and relatively easy to predict. For many operators, such as water companies, waste companies and local authorities, there is the opportunity to develop their own biomethane production to fuel their own vehicles, thus guaranteeing their own fuel costs many years into the future.

Noise reduction

Gas vehicles offer a substantial noise reduction over diesel vehicles, with a figure of 50% frequently quoted. Although the exact numbers will vary from vehicle to vehicle, data from Scania, presented by Cenex, suggests a noise reduction for their vehicles from ~70 dB(A) to ~60 dB(A) when switching from diesel to dedicated methane. As this is a logarithmic scale, this represents a very significant noise reduction – roughly from the noise of a vacuum cleaner to that of a dishwasher.

Diversion of waste from Landfill

As the economics currently stand, the use of biomethane in vehicles is unlikely to drive any additional diversion of waste from landfill over what would be likely anyway. The current rapid expansion of AD capacity in the UK is being driven largely by the positive returns on investment generated by installing electricity generation capacity.

However, if the price of diesel continues to rise, and gas refuelling infrastructure is installed, transport could quickly start to compete for gas resource and provide a significant additional driver for the installation of new AD capacity and further diversion of waste from landfill.

Job creation

Providing an accurate forecast of the additional jobs likely to be created as a result of investment in the use of biomethane for transport would be a highly complex task, and well beyond the scope of this project. However, a very rough forecast could be made on the basis of the scenario presented in section 2.1.2 above.

The scenario assumes that by 2020, 10% of the 100,000 articulated vehicles over 33t might run on dual fuel, each vehicle requiring a £25,000 conversion. It is also assumed that of these, 50% use CBM and 50% use CNG.

For the purposes of estimating job creation, several further assumptions are required:

- 100 large fuelling stations are needed to service these 10,000 vehicles, costing £500,000 each:
- Gas cleaning and compression plants are fitted to around 300 sites producing biogas, costing £500,000 each:
- Vehicles and infrastructure are introduced at a steady pace for 10 years – i.e. 1,000 vehicles, 10 fuelling stations and 30 sets of cleanup equipment are introduced each year:
- Total vehicle km for these vehicles remain static at 10 billion pa, as does their efficiency and that of the dual fuel vehicles.

All of these assumptions are very rough, and open to question. However, if accepted they imply a total spend on vehicles and equipment of £45 million per year (if spread evenly from now until 2020), and a total yearly spend of £500 million per year on biomethane as fuel by 2020.

One method of estimating job creation is to use a 'Type 2 multiplier', a figure for the number of jobs in different industries that are typically created per unit of spend. The Scottish government, for example, gives the following figures for the number of jobs created per million pounds spent in the selected sectors[11]:

- Gas distribution – 6.7 (jobs per £million spent)
- Oil processing – 10.3
- Motor vehicle manufacture – 14.4
- Motor vehicle repair – 25.6

Based on the figures above, it can be seen that we might expect between 6 and 14 jobs to be created per million pounds spent per year. If biomethane continued to be distributed by tanker, many more jobs would be created by its distribution than natural gas (albeit this is unlikely to be the most economically efficient approach) – if biomethane comes to be distributed by the gas grid, the figure above might be much closer to what is actually seen. It could also be that the conversion of vehicles is labour intensive, and much closer to vehicle repair in the number of jobs it creates.

Based on a spend of £545 million per year, and a central estimate of 10 jobs for every million pounds of that expenditure, a very rough estimate would be the creation of 5,450 jobs by 2020.

Although the estimate above depends upon an ambitious scenario and a wide range of untested assumptions, the underlying fundamentals of biomethane as a job creator are strong. In considering the creation of jobs in relation to the money spent, it is important to consider whether these jobs will be additional – the base assumption must be that the money would have been spent somewhere, so would it have created more or fewer jobs somewhere else?

[11] http://www.scotland.gov.uk/Topics/Statistics/Browse/Economy/Input-Output/Mulitipliers

The advantage of using biomethane as a transport fuel is that it is likely to keep its associated spending within the UK – reducing the 'leakage' of economic, job-creating benefit. Biogas, and biomethane produced from it, is a domestic resource, whereas an increasing proportion of any diesel is likely to have been imported. The same currently applies to vehicle conversions – although the majority of articulated HGVs will be manufactured outside the UK, two UK companies are currently the only source of the conversion. Finally, the development of additional UK infrastructure associated with biomethane, plus its maintenance, will provide employment that is intrinsically UK-based.

In conclusion, we would recommend further study to firm up the various assumptions made above, but suggest that as a transport fuel biomethane is inherently likely to provide greater employment opportunities within the UK than the equivalent use of diesel.

Development of export business

Although the UK lags behind many countries in its development and deployment of gas powered vehicles, it is leading in the development of 'dual fuel' vehicles (see section 1.2.4 below). Paradoxically, this is in part driven by our lack of fuelling infrastructure – dual fuel vehicles can switch to running on 100% diesel if they run out of gas, thus eliminating the 'range anxiety' that many operators feel when faced with investing in vehicles that just run on gas. Dual fuel technology has many advantages, and the two leading UK companies in this area are working closely with a variety of OEMs across Europe.

2.1.4 Use of biogas in vehicles versus other uses

A Carbon Trust report published 1st April 2010[12] found that using biogas as a vehicle fuel (i.e. after upgrading to biomethane) delivered the highest net CO_2e savings when compared with other uses. The report compared use as a transport fuel, use in CHP, electricity generation only and injection of the gas into the grid. It examined the CO_2 savings from displacing other energy sources, and included an analysis of the 'parasitic' loads associated with different uses of the gas – for example, the energy used in cleaning and compressing gas for use in vehicles.

The report found that at present, CHP and vehicle use give roughly the same net benefit (although in practice most current CHP installations at AD plant do not make full use of the heat generated). However, looking forward to 2020, when it is assumed that electricity production will be more extensively decarbonised than transport, the use of biogas in transport applications emerges as a clearer leader.

The report also examined the economics of these different uses of biogas. It found that for the operator of a 25,000 tonne pa food waste plant with gate fees of £40/tonne, the use of the gas as a transport fuel generated higher net revenue than electricity generation or injection of the gas into the grid. This finding remained with or without subsidies (Feed In Tariff for electricity, Renewable Transport Fuel Obligation for fuel and Renewable Heat Initiative for grid injection).

In practice, both the relative carbon savings and the relative financial benefits will depend on a number of variables. The cost of grid connection versus the cost of refuelling infrastructure and the proximity of a fleet of vehicles will have a major effect. The efficiency of electrical generation, and of different gas fuelled vehicles will also vary. Finally, the changing cost of electricity and diesel will have a major impact on the economic case.

However, the overall conclusion is that given current prices and technology, on average the use of biogas as transport fuel is more attractive in both carbon saving and financial terms than other available options.

[12] 'Biogas from Anaerobic Digestion', Carbon Trust, 1st April 2010, available at www.carbontrust.co.uk

2.2 Current barriers and incentives

2.2.1 Barriers to commercialisation and deployment

During the course of our research, the stakeholders interviewed identified four main barriers to widespread deployment of biomethane to power heavy duty vehicles. These were:

- The lack of refuelling infrastructure, and the capital costs of refuelling stations.
- The limited number of suppliers of biomethane.
- The lack of certainty with regard to government incentives and fuel duties.
- The (assumed) low residual value of gas powered vehicles.

Overcoming the capital costs of establishing a refuelling infrastructure is the single biggest barrier to deployment. While a strong business case can be made for vehicle purchase in many fleets, the cost of one or more permanent refuelling stations is much harder to justify without significant economies of scale, especially since it is up front expenditure that has to be made before any fuel savings are achieved. Without government support, only a very few operators at this stage are likely to be convinced enough to invest in the 10-20 vehicles that might make this investment worthwhile.

There is only one current supplier of biomethane in the UK, GasRec. This is less of a problem than it might first appear – GasRec could supply a lot more vehicles in the UK than it does at the moment (more than half of its gas is exported), and if its supply was exhausted, fleet operators could use natural gas instead. However, for many fleet operators, the main driver for switching to gas is customer pressure for carbon savings, which are much higher when using biomethane. Many of the operators we spoke to were concerned about the lack of choice and depth of supply, and also expressed concerns that a lack of competition probably meant they would pay monopoly prices for their gas.

Both fleet operators and gas producers expressed concern that the government had not provided enough reassurance regarding the continuity of incentives and duties. Given the up-front investment required to make use of biomethane in vehicles, and the importance of incentives and duties to the expected payback, confidence that those incentives will remain fixed until the investment has paid off is as important as the level at which they are set.

Some fleet operators expressed concern that they would not be able to roll out the use of gas powered vehicles because they could not guarantee a strong residual value at the end of the vehicle lease. For many operators, vehicles are procured under an operating lease based on the difference between purchase price and the residual. A gas powered vehicle will typically have a price premium of around £25,000, but in the current market it is assumed that this adds nothing to the residual value, meaning that the operating lease is too expensive.

2.2.2 Market incentives and legislation

Since biomethane production and use touches not just on transport but also on waste management and energy generation, a wide range of incentives and legislation influence its uptake.

Price mechanisms

As a vehicle fuel, natural gas is currently taxed at 35p less than diesel, a differential that the government has currently fixed until 2014. At present, diesel is taxed 57.19p/litre and gas at 22.16p/litre. This derogation applies equally to natural gas and biomethane, and is vital to the cost effectiveness of gas powered vehicles. Although gas powered vehicles are more efficient than diesel vehicles, until they are manufactured in large quantities their price premium will require this subsidy for them to be economic.

Since gas powered vehicles can use natural gas or biomethane, the wholesale price of natural gas sets an effective upper bound on the price of biomethane. Users will pay some premium for the extra carbon savings biomethane provides, but this is limited. (It would of course increase if carbon was directly priced in some way in the transport sector.)

The lower limit on the price of biomethane as fuel is effectively set by the other possible uses for biogas or biomethane. Most facilities producing biogas currently use it to generate electricity, often with a CHP unit. They can do this without investing in gas clean-up equipment, and can claim Renewable Obligation Certificates (ROCs) currently worth around 4.5p. The ROCs system is currently biased to incentivise certain sectors – thus a new AD plant processing food waste can claim 2 ROCs for every MWh of electricity generated, whereas a sewage treatment plant can only claim ½ a ROC per MWh, and a landfill only ¼ of a ROC. (This is because sewage treatment and landfill sites are regulated and have to deal with their methane, so do not require as great a subsidy to incentivise action.)

Smaller electricity generation plants, under 5 MW, can now claim Feed In Tarrifs (FITS) meaning they will receive 9p/kWh, fixed for 15-20 years.

If a biogas producer chooses to invest in upgrading their gas to biomethane, they can sell it as transport fuel, but will soon also be able to inject it into the gas grid. ‘Biomethane to Grid’ (BtG) will be eligible for the Renewable Heat Incentive (RHI), amounting to 4p/kWh. However, this will probably only be attractive to larger plants, as there will be significant investment required in equipment to prevent accidental contamination of the gas grid.

If a biomethane producer does decide to sell their gas as transport fuel, they will be able to claim Renewable Transport Fuel Certificates (RTFCs). Like ROCs, RTFCs are traded on the open market, with a ‘buy-out’ price at which a company that cannot source enough RTFCs would have to pay to the government in order to make up any shortfall in the number of RTFCs it submits at the end of the year. The buy-out price is currently set at 30p/litre, and although RTFCs are currently trading at well below this price, the rising percentage of biofuels required under the Renewable Transport Fuel Obligation is anticipated to push the price up towards this level.

As mentioned above, a recent report by the Carbon Trust[13] compared the income that gas producers could earn from generating electricity, selling the gas as transport fuel and injecting it into the grid. They concluded that in the absence of incentives transport provided the highest return, and that this was still the case with incentives (FITS, RTFCs and RHI) albeit with a much smaller margin between the three. It seems likely therefore that the capital cost of gas clean-up, combined with the small and uncertain market for biomethane transport fuel, may be dissuading many investors that might otherwise get good returns from providing gas to the transport sector.

Currently there is only one producer of biomethane in the UK, and the price they can charge is closely bounded by the upper and lower limits described above. However, if the prices of oil and gas rises, the price that could be charged for biomethane for transport may go up and should stimulate more producers to enter the market. Since the cost of producing biomethane is linked to the waste management industry rather than oil and gas production, it is likely that increased production of biomethane would create a widening price gap between biomethane and diesel.

[13] ‘Biogas from Anearobic Digestion’, Carbon Trust, 1st April 2010, available at www.carbontrust.co.uk

3 Viability of proposed demonstration

Overall, we found a very high level of interest and capacity amongst the stakeholders interviewed. The key limitation on the viability of the demonstration funding as proposed by the Department for Transport is the short timescale available for spending the money available.

3.1 Existence and status of potential funding recipients

A total of 29 potential consortia were identified, which accounts for probably most but not all of those likely to form in the near future.

15 of the consortia identified were demand side, led by fleet operators, and would purchase gas where available, currently only from GasRec. The remainder incorporate both gas supply and demand. They are those developing their own sources of gas, either local authority AD plant, sewage treatment plant or waste companies (either new AD capacity or landfill), with either their own or partner's fleets expecting to make use of the gas.

On the supply side, no new biogas sources, such as new AD plants, could be commissioned in timescale. However, there are many opportunities for gas clean-up equipment to be added to existing sources of biogas – usually in cases where there is an excess of gas over what can be used for electricity generation (as described in more detail above).

Of the possible consortia, at least 10 include partners that already have experience of running gas powered vehicles. At least a further three are already planning to start trials before the end of 2010.

3.2 Risks and mitigation

The key risks to successful delivery that we have identified are:

1. **A lack of initial interest in the programme**

   This is a moderate risk that has already in part been mitigated by the interviews conducted for this study. We would recommend that all those stakeholders that were interviewed for this study should be personally contacted by email as soon as possible after any decision is taken to proceed, in addition to any more general publicity.

2. **A lack of applicants due to the short timescale**

   As detailed above, the biggest barrier to the successful delivery of this programme is likely to be the time available for participants to spend the funds. This is dealt with in more detail in chapter 3, but our interviews with stakeholders suggest that there are enough consortia with plans that are significantly developed to constitute a strong field of credible applicants.

3. **Project delays causing underspend**

   This is a high risk, as the likely timescales on vehicles and infrastructure allow very little time for delay. This could be mitigated in part by reviewing all successful applications together before offer letters are sent to ensure that a range of equipment and vehicle providers are represented.

4. **Changes to legislation or incentives**

   Two areas have been identified that may impact on the proposed trial/demonstration. Firstly the Environment Agency is currently consulting on its standards for biomethane. There is concern from some of the stakeholders interviewed that they may require a standard of gas upgrading that is unnecessarily high and which therefore pushes up costs.

4 Options for design of grant scheme

AEA have explored various design options for a grant scheme that will see a successful spend of the allocated grant money by March 2011, while also meeting the key aims and priorities of the DfT.

We have identified three options that would lead to a feasible grant scheme, all with their associated advantages and disadvantages. These are:

Option 1. Demonstration Trial via a management contractor – Research & Development Grant
Option 2. Demonstration Trial via a management contractor – Environmental Protection Grant
Option 3. Capital Support of infrastructure via the Infrastructure Grants Programme (this would require funding for vehicles to be distributed via Option 1 or 2, or via another grant scheme)

The three options follow different State Aid routes, and use different delivery mechanisms. Table 8 summarises the main characteristics of each option and the main advantages and disadvantages. Sections 4.1 – 4.3 describe the options in greater depth.

Table 8: Design options with advantages and disadvantages

Option	Main characteristics	Main advantages	Main disadvantages
1. Demonstration Trial via a Management Contractor – Research & Development Grant	The grant would be for the demonstration of newly developed technology. The trial would run for a number of years with annual reporting on the results. Consortia would apply for this scheme.	R&D funding allows potentially high levels of grant % (up to 60% with SMEs and collaboration). The call for applications can go out to a number of established and interested consortia.	Commercially available equipment would be difficult to justify as eligible. The scheme would have to run for a number of years to reduce the residual value of the equipment at the end of the scheme (which would have to be paid back).
2. Demonstration Trial via a Management Contractor – Environmental Protection Grant	The grant would be for equipment that reduces environmental impacts. The trial would run for one year after March 2011. Consortia would apply for this scheme.	The rules surrounding eligibility are simpler – all equipment would be eligible. The call for applications can go out to a number of established and interested consortia.	Less funding is available (35% – 55%). The infrastructure would have to link in with the vehicle use, as the European Commission would not see the capital cost of the infrastructure on its own as being a reduction in environmental impacts.
3. Capital Support of Infrastructure via the Infrastructure Grants Programme	Grant funding via the IGP would not cover vehicle purchase, only the biomethane clean-up and infrastructure equipment. The scheme would not be a trial and would end after March 2011. Biomethane HDVs would be covered via another dedicated grant programme (such as the proposed DfT Green HGV trials)	Very fast start-up time means this is the most likely route for successful spend of grant monies by March 2011. Established programme means that the Call for Applications will reach more organisations.	Most funding through the IGP has gone to local authorities rather than to independent companies.

4.1 Option 1: Demonstration Trial via a management contractor – Research & Development Grant

Option	Main characteristics	Main advantages	Main disadvantages
1. Demonstration Trial via a Management Contractor – Research & Development Grant	The grant would be for the demonstration of newly developed technology. The trial would run for a number of years with annual reporting on the results. Consortia would apply for this scheme.	R&D funding allows potentially high levels of grant % (up to 60% with SMEs and collaboration). The call for applications can go out to a number of established and interested consortia.	Commercially available equipment would be difficult to justify as eligible. The scheme would have to run for a number of years to reduce the residual value of the equipment at the end of the scheme (which would have to be paid back).

The first option that is applicable for this type of grant programme would be to run a demonstration trial of demonstration or pilot projects under the Research and Development State Aid Block Exemption, to comply with Section 5 of the Science and Technology Act 1965. The regulation to be followed would be State Aid **Article 31**[14][15] *Aid for Research and Development projects*, Section 2(c) Experimental Development[16].

Groups of consortia would apply to the programme for a capital grant against the costs of the biogas clean-up kit, fuelling stations, associated infrastructure (such as fuel bunkers), and biomethane HDVs. The consortia would typically consist of a fuel provider and a vehicle owner/operator. It would not be unusual to see applications involving biogas clean-up manufacturers, estate owners, and vehicle manufacturers, however they are more likely to be used as subcontractors for the purchasing of the equipment, rather than be involved in the running of the demonstration project.

Eligible costs

The eligible costs under the Research and Development route are the entire capital costs of the project, including staff costs, the depreciation costs corresponding to the equipment during the life of the project, and the depreciation costs corresponding to any buildings and land during the life of the project.

Regarding capital vs non-capital costs; there is no limit on the breakdown of costs, however a sensible limit, as used in the Department of Energy and Climate Change (DECC) Smart Grids Demonstration Programme, would be to limit non-capital costs to a maximum of 10% of the total project costs. This would ensure that the vast majority of grant would go to tangible capital.

In order to comply with the R&D State Aid rules surrounding residual value at the end of a trial (Article 31(5)(b) and (c)), we would propose that this option last for a period of 5 years of reporting, starting in April 2011. The projects would submit an annual report on the performance of the trial. At the end of the 5 year monitoring and reporting period, it would be feasible to argue that there maybe a residual value in the equipment, as even though the technology is expected to have progressed significantly at that point the equipment may still be in use. This would mean that only a percentage of the costs of the equipment would be eligible costs at the time of application. This structure could potentially cause some issues in the case of temporary equipment, such as temporary filling stations, as they may not be designed or intended to be in place for 5 years. Also, operators may not be willing to enter into an obligation to maintain the use of the vehicles for a full 5 years.

[14] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:214:0003:0047:EN:PDF

[15] http://ec.europa.eu/competition/state_aid/studies_reports/vademecum_on_rules_09_2008_en.pdf

[16] Commission Regulation (EC) No 800/2008 of 6 August 2008 declaring certain categories of aid compatible with the common market in application of Articles 87 and 88 of the Treaty (General block exemption Regulation) (OJ L 214, 09.08.2008, p 3).

4.1.1 Aid Intensity

Basic Intensity
Article 31 (3)(c) dictates that the basic aid intensity for experimental development is a maximum of 25% of eligible costs.

Article 31(4)(a) Uplift for SMEs
An organisation classified as a Small or Medium Sized Enterprise (SME) can apply for uplifts of up to 20%. For medium-sized enterprises, the maximum increase is 10%. For small and micro-sized enterprises, the maximum increase is 20%.

To be classified as an SME, an organisation must be independent and have:

Enterprise category	Headcount	Turnover	or	Balance sheet total
medium-sized	< 250	≤ € 50 million		≤ € 43 million
Small	< 50	≤ € 10 million		≤ € 10 million
Micro	< 10	≤ € 2 million		≤ € 2 million

Further information on the definition of an SME is available at:
http://ec.europa.eu/enterprise/enterprise_policy/sme_definition/index_en.htm

Article 31(4)(b) Uplift for Collaboration
In addition, where projects involve an active and demonstrated collaboration between a large company and at least one SME, the maximum percentage limits can be increased by a further 15%.

Therefore the maximum percentage grant limit for a Large Company, medium SME and small SME in an active collaboration would be 40%, 50% and 60% respectively.

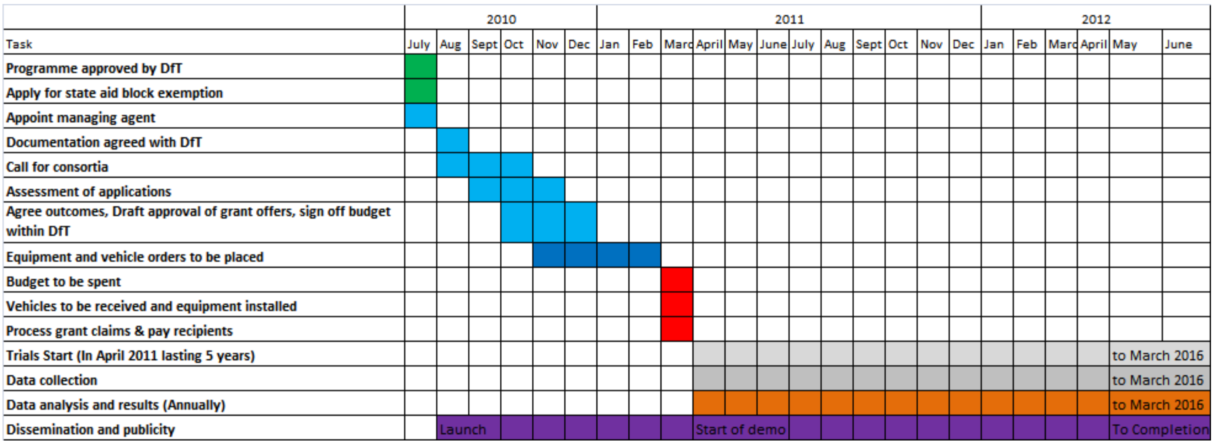
4.1.1 Timing of the Programme

The timeline below (Figure 1) shows the proposed timescales that Option 1 would allow. Within this proposed structure, the call for applications could be issued in August 2010, with a rolling assessment process allowing grant offers to be issued by October 2010. The proposed assessment process is discussed in more detail in Section 4.3 of this report. This would allow 5 months for delivery of equipment and vehicles. Given that the market is pre-warned and keyed to act on this grant programme, this timescale is feasible for vehicles, but may present problems for gas clean up and refuelling infrastructure and could limit the number of applications for these items.

Completion of projects, and completion of grant spend is timetabled during March 2011. Past this point, an annual reporting cycle would be entered, where the results of the trial are fed back to DfT for a period of 5 years. A final report on project performance would be submitted in March 2015.

The critical time periods in this structure are:
- Agreeing the call documentation
- Approving the grant allocations and budget within DfT
- Processing of grant payments before 31st March 2011

Figure 1: Timeline for Option 1: Demonstration Trial via a management contractor – Research & Development Grant



4.2 Option 2: Demonstration Trial via a management contractor – Environmental Protection Grant

Option	Main characteristics	Main advantages	Main disadvantages
2. Demonstration Trial via a Management Contractor – Environmental Protection Grant	The grant would be for equipment that reduces environmental impacts. The trial would run for one year after March 2011. Consortia would apply for this scheme.	The rules surrounding eligibility are simpler – all equipment would be eligible. The call for applications can go out to a number of established and interested consortia.	Less funding is available (35% – 55%). The infrastructure would have to link in with the vehicle use, as the European Commission would not see the capital cost of the infrastructure on its own as being a reduction in environmental impacts.

The second option that is applicable for this type of grant programme would be to run a demonstration trial under the Environmental Protection State Aid Block Exemption, to comply with Section 5 of the Science and Technology Act 1965. The regulations to be followed would be State Aid **Article 18**[17][18] *Investment aid enabling undertakings to go beyond Community standards for environmental protection or increase the level of environmental protection in the absence of Community standards*[19] and **Article 19** *Aid for the acquisition of new transport vehicles which go beyond Community standards or which increase the level of environmental protection in the absence of Community standards.*

Groups of consortia would apply to the programme for a capital grant against the costs of the biogas clean-up kit, fuelling stations, associated infrastructure (such as fuel bunkers), and biomethane HDVs. The consortia would typically consist of a fuel provider and a vehicle owner/operator. It would not be unusual to see applications involving biogas clean-up manufacturers, estate owners, and vehicle manufacturers, however they are more likely to be used as subcontractors for the purchasing of the equipment, rather than be involved in the running of the project.

Eligible costs

The eligible costs under Environmental Protection are the extra investment costs necessary to achieve a level of environmental protection higher than the level required by the Community standards concerned, without taking account of operating benefits and operating costs.

[17] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:214:0003:0047:EN:PDF

[18] http://ec.europa.eu/competition/state_aid/studies_reports/vademecum_on_rules_09_2008_en.pdf

[19] Commission Regulation (EC) No 800/2008 of 6 August 2008 declaring certain categories of aid compatible with the common market in application of Articles 87 and 88 of the Treaty (General block exemption Regulation) (OJ L 214, 09.08.2008, p 3).

‘*The extra investment costs shall be established by comparing the investment with the counterfactual situation in the absence of State aid; the correct counterfactual shall be the cost of a technically comparable investment that provides a lower degree of environmental protection (corresponding to mandatory Community standards, if they exist) and that would credibly be realised without aid (‘reference investment’); technically comparable investment means an investment with the same production capacity and all other technical characteristics (except those directly related to the extra investment for environmental protection); in addition, such a reference investment must, from a business point of view, be a credible alternative to the investment under assessment. where no standards exist, the eligible costs shall consist of the investment costs necessary to achieve a higher level of environmental protection than that which the undertaking or undertakings in question would achieve in the absence of any environmental aid*.’ Article 18 (6) and Article 19 (6)

This means that in the case of a Biomethane Demonstration Trial, the eligible costs for most of the equipment would be the cost of installing/purchasing biomethane related equipment, minus the cost of installing/purchasing the same type of equipment for a fossil fuel alternative, i.e. diesel. This part of the regulation is based on the assumption that the more environmental routes are always more expensive than the less environmental routes, and so there is always a marginal cost associated with environmental protection.

Regarding capital vs non-capital costs; there is no limit on the breakdown of costs, however a sensible limit, as used in the Department of Energy and Climate Change (DECC) Smart Grids Demonstration Programme, would be to limit non-capital costs to a maximum of 10% of the total project costs. This would ensure that the vast majority of grant would go to tangible capital.

In which case, the likely comparable investments would break down as:
- Biomethane storage would be compared to diesel bunkering
- Biomethane filling stations would be compared to a fossil fuel (petrol and diesel) filling station.
- Biomethane vehicles would be compared to their diesel equivalents

Unfortunately, it is not possible to assume a level of ‘fossil fuel deduction’ that can be deducted from the total project costs, in order to find the marginal costs. Similar programmes, such as the Department of Energy and Climate Change’s Bio-Energy Capital Grants Scheme, use an assumption based on £ per kW to be installed. As this programme could have highly varying components between applications, it would not be sensible to assume a level of deduction that would work across the board. For this reason, we would suggest putting the onus on the applicants to provide evidence to justify their marginal cost calculations, such as providing the comparative cost of a fossil fuel filling station to compare to a biomethane filling station.

4.2.1 Aid Intensity

Basic Intensity
Article 18 (4) and Article 19 (5) dictate that the basic aid intensity for environmental protection is a maximum of 35% of the marginal costs of the project.

Article 18(4) and Article 19 (5) Uplift for SMEs
An organisation classified as a Small or Medium Sized Enterprise (SME) can apply for uplifts of up to 20%. For medium-sized enterprises, the maximum increase is 10%. For small and micro-sized enterprises, the maximum increase is 20%.

To be classified as an SME, an organisation must be independent and have:

Enterprise category	Headcount	Turnover	or	Balance sheet total
medium-sized	< 250	≤ € 50 million		≤ € 43 million
small	< 50	≤ € 10 million		≤ € 10 million
micro	< 10	≤ € 2 million		≤ € 2 million

Therefore the maximum percentage grant limit for a Large Company, medium SME and small SME would be 35%, 45% and 55% respectively.

Further information on the definition of an SME is available at:
http://ec.europa.eu/enterprise/enterprise_policy/sme_definition/index_en.htm

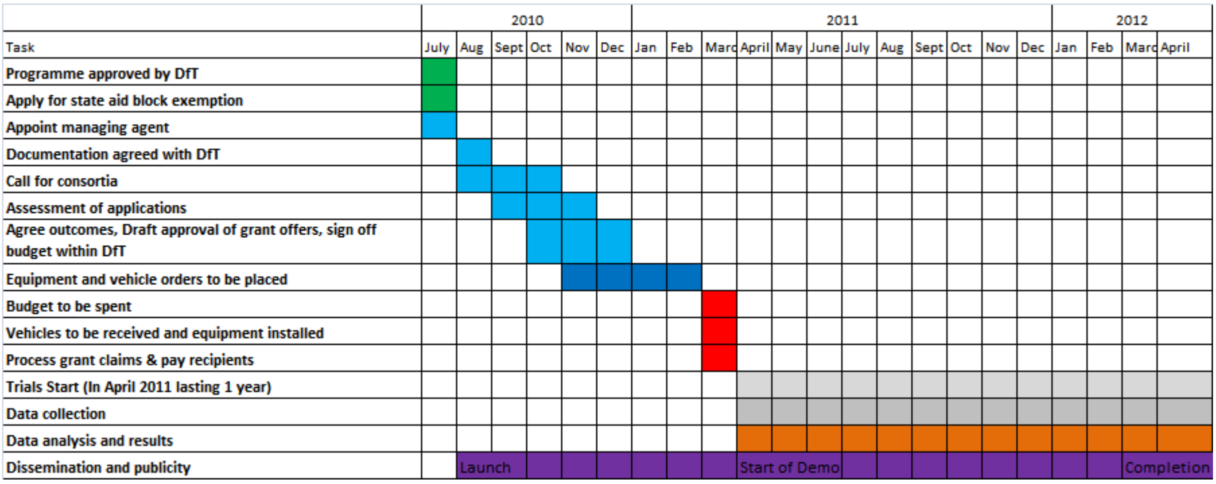
4.2.2 Timing of the Programme

The timeline below (Figure 2) shows the proposed timescales that Option 2 would allow. Within this proposed structure, the call for applications could be issued in August 2010, with a rolling assessment process allowing grant offers to be issued by October 2010. The proposed assessment process is discussed in more detail in Section 3.5 of this report. This would allow 5 months for delivery of equipment and vehicles. Given that the market is pre-warned and keyed to act on this grant programme, this timescale is feasible for vehicles, but may present problems for gas clean up and refuelling infrastructure and could limit the number of applications for these items.

Completion of projects, and completion of grant spend is timetabled during March 2011. Past this point, a period of data collection would be entered, lasting 1 year. A final report on project performance would be submitted in March 2012.

The critical time periods in this structure are:
- Agreeing the call documentation
- Approving the grant allocations and budget within DfT
- Processing of grant payments before 31st March 2011

Figure 2: Timeline for Option 2: Demonstration Trial via a management contractor – Environmental Protection Grant



4.3 Option 3: Capital Support of Infrastructure via the Infrastructure Grants Programme

Option	Main characteristics	Main advantages	Main disadvantages
3. Capital Support of Infrastructure via the Infrastructure Grants Programme.	Grant funding via the IGP would not cover vehicle purchase, only the biomethane clean-up and infrastructure equipment. The scheme would not be a trial and would end after March 2011. Biomethane HDVs would be covered via another dedicated grant programme (such as the proposed DfT Green HGV trials)	Very fast start-up time means this is the most likely route for successful spend of grant monies by March 2011. Established programme means that the Call for Applications will reach more organisations.	Most funding through the IGP has gone to local authorities rather than to independent companies.

The third option that AEA have explored would be to run a biomethane infrastructure grant programme via the existing Infrastructure Grants Programme (IGP) currently managed by Cenex until July 2011.

Having liased with the IGP team, we can confirm that they are confident that an infrastructure round specifically for biomethane could be run successfully within the given timeframes. The one major step that would need to be undertaken would be an application for State Aid Block Exemption, under **Article 18**[20][21] *Investment aid enabling undertakings to go beyond Community standards for environmental protection or increase the level of environmental protection in the absence of Community standards*[22]*.* This can be achieved relatively quickly, and a submission can be made up to 2 weeks after the call for proposals has been announced. The reason for this is that the current IGP state aid approval via the De Minimis temporary framework for environmental protection will end on the 31st December 2010.

The extended round would follow the same structure as Option 2 via Environmental Protection. The main differences of utilising the IGP would be the speed of turn-around in launching the call for proposals, and the length of the project past March 2011. The normal IGP programme would not normally require data to be monitored after the project is complete and the grant has been paid. However, it could be included in the requirements for this round that the grantees report on usage data for one year after completion of the capital spend.

The main advantage of this route however, is that it matches what the industry is saying is needed. The vast majority of stakeholders that have been contacted have said that the key barrier to development of biomethane as a transport fuel is the current lack of infrastructure.

4.3.1 Timing of the Programme

The timeline below (Figure 3) shows the proposed timescales that Option 3 would allow. Within this proposed structure, the call for applications could be issued by the end of July 2010, with a rolling assessment process allowing grant offers to be issued by September 2010. The proposed assessment process is discussed in more detail in Section 3.5 of this report. This would allow 6 months for delivery and installation of equipment, which is feasible if the market is pre-warned and keyed to act on this grant programme.

Completion of projects, and completion of grant spend is timetabled during March 2011. A final report on project completion would be submitted in March 2011.

[20] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:214:0003:0047:EN:PDF

[21] http://ec.europa.eu/competition/state_aid/studies_reports/vademecum_on_rules_09_2008_en.pdf

[22] Commission Regulation (EC) No 800/2008 of 6 August 2008 declaring certain categories of aid compatible with the common market in application of Articles 87 and 88 of the Treaty (General block exemption Regulation) (OJ L 214, 09.08.2008, p 3).

The critical time periods in this structure are:

- Approving the existing call documentation
- Approving the grant allocations and budget within DfT
- Processing of grant payments before 31st March 2011

Figure 3: Timeline for Option 3: Capital Support of Infrastructure via the Infrastructure Grants Programme

	2010						2011			
Task	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Marc	April
Programme approved by DfT										
Apply for state aid block exemption										
Appoint managing agent (Cenex)										
Documentation agreed with DfT										
Call for consortia										
Assessment of applications										
Agree outcomes, Draft approval of grant offers, sign off budget within DfT										
Equipment orders to be placed										
Budget to be spent										
Equipment installed										
Process grant claims & pay recipients										
Dissemination and publicity		Launch							Completion	

4.3.2 Option 3A: Proposed Route to cover Biomethane HDVs

Following Option 3 via the IGP would not cover biomethane HDVs. Therefore, a separate grant mechanism is needed. This could be achieved via three routes:

1. Extend the coverage of the proposed **Green HGV trials** also currently undergoing a feasibility study. The Freight and Logistics Division at DfT have confirmed that they would be willing to include biomethane HDVs in the eligible technologies for the trials.
2. Form a separate vehicle trial using the State Aid Block Exemption for New Transport Vehicles which Increase the Level of Environmental Protection (Article 19[23]). This would follow the structure described in Option 2 above regarding the vehicles.
3. *Use the De Minimis State Aid route to offer grants of up to £100,000 Euros. This route would not normally be considered as HGVs are not eligible for this route. It has been suggested that this rule may have been amended, but at the time of writing this report, we were unable to confirm this with the Department for Business, Innovation and Skills (BIS).*

We would recommend that the first route is the most sensible to follow, given that the Freight and Logistics Division have already confirmed that they are willing to do this.

4.4 Procurement Routes for the Management Contractor

In the context of this project, the key question in the appointment of a management contractor is the speed with which this could be accomplished. The procurement routes considered were appointing the managing agent via open call (OJEC), via an existing DfT framework, via the Technology Strategy

[23] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:214:0003:0047:EN:PDF

Board or by expanding an existing programme (e.g. the Infrastructure Grants programme). The following issues need to be considered:

- If the Environmental Protection State Aid route were taken it would rule out the Technology Strategy Boad (TSB) for Option 2 as only R&D would fit with its remit and portfolio.
- If an open call were to be run via OJEC the timeframe would be 4 to 6 months. This rules this option out as there would not then be time to get equipment installed and vehicles delivered by March 2011.
- If the DfT appointed the management contractor via one of its existing framework agreements, they could be put in place within a short time frame (approximately 4 weeks). They would need to have existing experience of running grant programmes in order to develop the call documentation to an agreed level within 4-5 weeks of being in contract.
- If the DfT appointed the IGP team at Cenex to undertake the management of the infrastructure side of the grant programme, they would be able to open a call within 4 weeks of notification from DfT. The call documentation is already set-up, and the IGP team are keen to promote the programme through well defined channels of communication. Taking this route would mean that the Green HGV trial programme, or a separate grant programme for biomethane vehicles would be needed, as the IGP cannot cover vehicles.

Table 9: Possible procurement routes

Procurement Route	Advantages	Disadvantages	Comments
Technology Strategy Board	TSB manage a number of grant programmes and are currently running a trial of electric vehicles	R&D programmes fit well with TSB, but the Environmental protection state aid route would not fit well.	The state aid route of R&D is the least fitting with the Biomethane demonstration programme so this procurement route is not recommended.
Open call via OJEC	A wide choice of managing agents and ability to select the most suitable organisation to do the job.	It will take 4 to 6 months to run a call in OJEC.	The duration rules this option out as the projects would not be able to complete and claim the grant before March 2011.
Existing DfT Frameworks	Contracts can be put in place in a matter of a few weeks. Some organisations within the frameworks have good experience of running grant programmes combined with good technical knowledge of the field.	The value of the contract to the managing agent may be limited by the constraints of the framework chosen to deliver this work.	This would be our recommended option if the Environmental Protection State Aid route is taken, for speed of delivery combined with experience of running grant programmes and knowledge of the field.
Infrastructure Grants Programme	The IGP is already in existence and the managing agent has experience of running grant programmes.	This is designed to provide grants towards the installation of infrastructure and so would only work if the vehicle element of the programme was split from the infrastructure and handled separately.	This would be our recommended option if DfT are able to split the programme between demand-led projects (vehicles), and supply-led projects (infrastructure).

4.5 Suggested Selection Criteria

The underlying rationale behind the proposed assessment process is that it should be as objective as possible. Applications would first be assessed for eligibility to apply to the programme. This would include an assessment of the level of funding applied for, the type of organisation/consortia, the location of the project, and the timescales of the project. Applications that do not meet these terms would be judged non-compliant and would not be assessed further.

For all compliant applications, the Applicants and each partner in any consortium would then be subject to a financial viability test and must provide the requisite financial information to facilitate this process. Applications from any organisation failing the test, or involving a consortium that includes any organisation failing the test, would also be considered ineligible.

We would suggest that the programme be classed and promoted as competitive and therefore each eligible application would be assessed and scored against the following suggested criteria:

1. **Relevance**
    - How well do the aims and objectives of the proposed project match those of the DfT programme?
    - How well does the project match the DfT priorities?

2. **Technical credibility**
    - How technically sound is the proposed project and how likely is it to deliver the objectives? This would cover technologies employed and technical support. How advanced is the status of the necessary permissions (such as planning permission)?
    - How credible is the project plan in terms of costs and timescales for (e.g.) installation and commissioning?
    - How credible are the objectives proposed? Has the proposal identified development targets or performance targets? If so how credible are they?

3. **Credibility of the Applicants**
    - Do the Applicants have the right skills and track record to deliver the objectives and will the project be properly managed?
    - Does the proposal identify how the equipment will be sourced/procured?

4. **Evaluation and dissemination**
    - How credible are the measures to evaluate the performance of the project and disseminate the results? How well do they contribute to the aims of the Programme?
    - Have resources been allocated to performance evaluation?

5. **Cost Benefit**
    - The applicant would be asked in the application form to provide an outline cost benefit assessment (defining any assumptions made) for the technology being demonstrated. These would be reviewed as part of the proposal assessment process.
    - How will the technology improve the sector/uptake of the technology?

6. **Replication Potential**
    - The applicant would be asked to provide an assessment of the replication potential for the technology demonstrated. This should be by specific examples rather than a generalised statement.
    - If the replication potential is low, are there other reasons why the technology is important and should be demonstrated?

7. **Risk Management and Consents**
    - The applicant would be asked to address the risks in their proposed project and demonstrate a risk mitigation strategy.
    - Where consents are required the applicant would be asked to show they are approved or that the process is underway.

To be considered for funding, an application would have to meet all of the above criteria. Applications would then be ranked by score according to their merit against all the criteria. Weightings could be applied to each scoring criteria to reflect the priorities of DfT.

4.5.1 The Funding Decision

A Project Board consisting of technical experts, the management contractors, and the DfT team will review the technical assessment recommendations and consider other relevant factors to identify the most appropriate projects to fund. Not all of the available funds may be awarded.

Grant Offer Letters and letters of rejection would then be drafted and approved by the DfT before being issued to the applicants.

It is recommended that a rolling grant application and approval process is run to speed up the award of grants.

4.6 Overall Risk Assessment

AEA have assessed the major risks to this project, and ranked them in order of our perceived importance (see Table 10). The higher the risk is on the list, the more essential it is to address in order for a successful programme to take place.

Table 10: Overall Summary Risk Assessment

Risk	Rating	Mitigation Measure
Equipment is not delivered and installed in order to claim the grant by the 31st March 2011	High	The management agent must be chosen on the criteria of experience of managing grant programmes. It is key for the management agent to get all documentation agreed and the call for proposals launched at an early a stage as possible.
Only a few applications are received – the grant money is not all allocated	High	The industry needs to be warmed up in preparation for the programme, with open and regular communications from DfT.
Delays in supply of equipment	High	Most of the equipment that would be eligible for this programme is made to order and so the lead times between order and delivery are crucial if equipment is to be delivered in time to be able to claim the grant. The biggest risk for this demonstration project is failing to place orders in time to allow the project to be delivered by March 2011. It may be possible to identify the components that have the greatest lead time and where possible get manufacturers to stock pile these in the run up to orders being received.
Projects drop out of the grant programme after receiving a grant offer – funds are not available for alternative applications	Medium	There is usually about a 20% drop-out rate in most grant programmes, either due to financial issues, or delays caused by planning permission etc. To manage this risk appropriately, it would be sensible to over-allocate the grant budget to take account of some of the drop-out projects.
Impact of the demonstration	Low	It is important to build in an analysis of the programme delivery against its objectives, especially a consultancy with industry. From this, it is possible to judge the impact of the programme on the industry as a whole. It is also important to understand what the market is doing and what manufacturers are planning within the timeframe of the demonstration project so that the most appropriate technology is included in the demonstration project.
Public Image/perception of organisation and technologies taking part in the trial	Low	It is important to carefully manage the publicity relating to the trial so that coherent messages are put across, the profile of the programme is maximised and the results are presented in a positive way. It is important to the success of the demonstration and the future uptake of the technologies that any negative results are clearly understood so that the reputation of the technology and organisations taking part in the programme are not damaged.

4.7 Recommended allocation of funds

Our recommendation to the D*f*T is that the £3.5m available is split the between supply-led projects (infrastructure) and demand-led projects (vehicles).

1) The supply-led projects (infrastructure) could be delivered within the specified timeframe via an extension of the existing Infrastructure Grants Program (IGP) for **infrastructure only**. The consortia that bid for the infrastructure grant must prove that 100% of the biomethane will be used for vehicles only.

2) We recommend that the demand-led projects (vehicles) are delivered through the **Green HGV** program with a caveat that any funding specified for biomethane vehicle is specifically used for that purpose.

We recommend that £2m of the £3.5m available is available for infrastructure only and £1.5m is transferred to the Green HGV project. The rationale for this is as follows.

The funding allocated for infrastructure needs to be greater because there is a general need for more refuelling stations (both private and retail) across the UK. With £2m available to cover the marginal cost of a gas refuelling station in comparison to diesel, this sends out a strong signal to the industry that this is very important and that the D*f*T wish to receive a greater number of applications for funding. As outlined previously, the % funding is a minimum of 35% with uplifts of up to 20% depending upon the size of the company. Therefore there is the possibility of a number of consortium receiving 35-55% of the marginal cost of a gas refuelling station compared to a conventional petrol/diesel refuelling station. Initial estimates are that this funding could help to provide more than six new refuelling stations across the UK. Each capable of refuelling approximately 10-12 heavy duty vehicles.

The £1.5m for biomethane vehicles is a large allocation given that for example the marginal cost of a gas powered Refuse Collection Vehicle (RCV) compared to a standard diesel vehicle is approximately £25,000. Theoretically, £1.5m would be enough to provide upto 60 gas powered RCVs. A substantial and significant amount for a series of demonstration trials.

5 Recommended follow-up considerations

If the Department chooses to go ahead with a trial or demonstration of biomethane powered vehicles as per one of the options outlined in this report, we recommend that the following are considered in planning the follow-up:

1. **Plan communications**

   The results of this and other recent studies underpin the conclusion that although biomethane holds great potential as a transport fuel, it is currently held back by a lack of credible information on vehicle/equipment performance. It also requires collaboration between companies that might not ordinarily connect, in waste/water management and freight transport. A clear and well resourced programme to disseminate the findings of the trial/demonstration, and to facilitate communication between different stakeholders, will be vital to realise the full potential of any funds invested.

2. **Progress standards**

   The development of standards for vehicle homologation and maintenance needs to be progressed.

3. **Review incentives**

   A review of the incentives for different uses of biogas, in consultation with the Department of Energy and Climate Change, would allow these to be effectively targeted at the most cost effective ways to cut CO_2e emissions.

4. **Explore options for providing finance**

   Given that one of the main barriers to deployment is funding capital expenditure, rather than overall cost effectiveness in the medium term, low interest or interest free loans such as those provided by the Carbon Trust could be a more cost effective means of support than grants.

5. **Provide a clear strategy**

   In conjunction with all of the above actions, many of the stakeholders interviewed for this project expressed a desire for the government to provide a clear strategic direction for the deployment of natural gas and biomethane as transport fuels. Of particular concern is the strategy with regard to gas distribution – this could either continue to be independent of the gas grid, or could move towards a situation where biomethane is injected into the grid and then taken out elsewhere, in the same way as both ‘green’ and ‘brown’ electricity is distributed and sold via a single grid.

Appendices

Appendix 1: Study methodology

Appendix 2: Details of stakeholder interviews

Appendix 3: State Aid briefing note

APPENDIX 1: Study methodology

In order to complete this feasibility study, AEA conducted an initial literature review, an extensive consultation exercise, attended various forums and meetings and produced a draft final and final report to the D*f*T. In more detail AEA technology carried out the following tasks:

- Conducted a literature review of biomethane in the UK with a focus on developing a high level business case.
- Consulted with CENEX/LowCVP/DfT and others in the industry including Colin Matthews (Joulevert), Andrew Whittles (Low Emission Strategies), John Baldwin (CNG Services) and John Harwood (Gasrec) to produce a consultee list.
- Developed a questionnaire to be used in conducting interviews with each of the consultees identified.
- Emailed this questionnaire to each of the consultees (approximately 100) including every UK Government Office contact provided by D*f*T. Responses were filtered, and individual one-on-one consultations scheduled and carried out.
- Attended a meeting in London with Greg Archer and Jonathan Murray LowCVP to seek support and guidance to carrying out the project.
- Attended and presented at an REA Biogas meeting held at Chesterfield Biogas on the 13th May to advertise the project to a UK biomethane audience.
- Presented and advertised the project on a Webinar hosted by LowCVP on the 26th May.
- Wrote up the findings of the interviews, meetings and presentations into a draft report.
- Commissed staff within AEA, with experience of delivering demonstration projects affected by state aid rule, to investigate the optimal routes to delivery and to provide a recommendation
- Attended a meeting with the D*f*T Freight transport group on Monday 7th June and a final meeting with the D*f*T to present the findings from the study on Tuesday 15th June.
- Presented all the results and findings in a draft and final form to the D*f*T.

APPENDIX 2: Details of stakeholder interviews

Name		Organisation	Date
Andy	Graves	RosRoca IMA	18-May
Andrew	Whittles	Low Emission Strategies	27-May
Catherine	Crouch	Tenens Environmental	19-May
Callum	Johnson	Camden Borough Council	27-May
Chris	Banks	Greenwich Borough Council	26-May
Chris	Manson-Whitton	Progressive Energy	19-May
Colin	Matthews	JouleVert	18-May
David	Lawson	STRI Ltd	19-May
Dave	Pounder	Kelda Water	24-May
Doug	Leaf	GasRec	18-May
Doug	Robinson	Linc CC	21-May
Gerald	Tetchner	Enertech Consultants	20-May
Graeme	Walker	Thames Water	18-May
Graham	Rice	Ineos	25-May
Greg	Hilton	Bidwells	26-May
Ian	Handley	Dennis Eagle	18-May
James	Ingall	GasRec	18-May
James	Skinner	Sustraco Ltd	26-May
James	Patterson	Gas Fuelling Technology Ltd	18-May
Jim	York	DHL Supply Chain	25-May
John	Baldwin	CNG Services	19-May
Julian	Marks	Barfoot Energy	26-May
Mark	Wheaton	JB Wheaton	24-May
Neville	Stork	Leicester City Council	20-May
Nick	Power	BOC	19-May
Owain	Price	VW	27-May
Owen	Yeatman	Biogas Nord UK Ltd	24-May
Patrick	Cook	EON Engineering	26-May
Peter	Crowe	Hamworthy	26-May
Phil	Moon	DAF	28-May
Ray	Cattley	Volvo	26-May
Richard	Crowther	Leeds City Council	27-May
Richard	Smyllie	ENTEC UK	23-May
Robert	Evans	CENEX	24-May
Robin	Szmidt	Kuttner (UK) Ltd	18-May
Roy	James	Chive Fuels	26-May
Steve	Whelan	Clean Air Power	26-May
Steve	Simmons	Sheffield City Council	26-May
Tom	Megginson	GWE biogas	19-May
Winston	Reed	Greener for Life	26-May
Ray	Collington	John Lewis Partnership	04-Jun
Dino	Papas	Tesco.com	04-Jun
Gary	King	Sainsbury's	09-Jun

APPENDIX 3: State Aid Briefing Note

Background

State Aid rules aim to ensure fair competition and a single common market. Giving favoured treatment to some businesses would: harm business competitors; risk distorting the normal competitive market; and hinder the long-term competitiveness of the Community. Article 87(3)(c) of the EC Treaty allows State Aid that promotes economic development and other legitimate policy objectives, where this benefit outweighs any distortion of competition.
Generally Member States are required to notify the Commission of any plan to grant or alter State Aid – unless it is of a type exempted from notification by a legal regulation - and they are not allowed to put such aid into effect unless and until the Commission has approved it.
In the UK, the State Aid Branch within the Department for Business Innovation and Skills (BIS) is the channel through which notifications seeking EC approval for State Aid are be routed.
Applying for State Aid Block Exemption allows for projects under either of the two categories identified below to be given aid without a full submission for State Aid approval to the Commission.
The Member State (i.e. the project representative at DfT) has to complete an application form, indicating the type of State Aid Block Exemption they are applying for, and providing information on the priorities and criteria of the proposed grant scheme. The application can be made up to two weeks after the grant scheme is launched.

At the end of the grant spend period, the Member State has to submit information sheets on the implemented aid.

Options

The proposed grant scheme represents a form of State Aid that must comply with State Aid regulations. There are a variety of Regulations and Frameworks which govern State Aid of which the most relevant include:

State Aid for Environmental Protection (*Section 4, Articles 18 and 19*)
The guidelines identify a series of measures for which State aid may be permissible including incentives to companies to achieve higher environmental protection. Those potentially relevant to the project include for example:

a) Article 18 "Aid for undertakings which go beyond Community standards or which increase the level of environmental protection in the absence of Community standards" - *Allows Aid "that accelerates market diffusion of "eco-innovations".*
Aid Intensity = 35% (pus 20% for small enterprises, and 10% for medium enterprises)

b) Article 19 "Aid for the acquisition of new transport vehicles which go beyond Community standards or which increase the level of environmental protection in the absence of Community standards - "*It is particularly important to encourage the acquisition of clean transport vehicles"*
Aid Intensity = 35% (pus 20% for small enterprises, and 10% for medium enterprises)
In both cases, eligible costs are those that are required to undertake the project over and above the standard costs for non-environmental equipment (i.e. the cost of a biofuel HDV over and above the cost of a normal HDV).

State Aid for Research and Development and Innovation (*Section 7, Article 31*)
This framework allows State Aid for experimental development. The development of commercially usable prototypes is allowed as experimental development. Whilst a higher level of support would be allowed under 'industrial research' there are greater constraints and eligibility will depend very much on the detailed intent and design of the project.
Aid Intensity = 25% (plus 15% for collaboration where no partner has more than 75% of the costs, pus 20% for small enterprises, and 10% for medium enterprises)

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