Annex to the Low Emission HGV Task Force recommendations on the use of natural gas and biomethane in HGVs.

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Executive summary

1. It is widely recognised that the UK needs to significantly reduce its greenhouse gas emissions. HGVs are responsible for over 20% of domestic transport emissions\(^1\). Displacing diesel with methane, and particularly biomethane, can provide significant carbon savings which are unmatched by any other currently available measures. This would also help the UK to meet EU air quality standards by reducing emissions from diesel. This document considers a range of issues which will affect the use of methane and biomethane in HGVs and supplements the Low Emission HGV Task Force recommendations for enabling the greater use of gas in HGVs.

2. This document has been developed in consultation with members of the Low Emission HGV Task Force working group. It contains views and information from a range of sources including industry experts, Government Departments and published research.

3. Unless explicitly stated, the contents of this document do not reflect the views of any one person, organisation or Department.

\(^{1}\) 2011 National Atmospheric Emissions Inventory
1. Introduction

Context: reducing carbon emissions

1.1 In 2011, Heavy Goods Vehicles (HGVs) contributed 21% of surface transport greenhouse gas emissions\(^2\); around 23.1 million tonnes of carbon dioxide equivalent (MtCO\(_2\)e) out of a total of 112 (MtCO\(_2\)e), although HGVs make up only 1.5% of road vehicles.

1.2 The 2008 Climate Change Act set a target 80% reduction in overall greenhouse gas (GHG) emissions by 2050 and the HGV sector will need to contribute to the reduction. This will be especially challenging given that under business as usual scenarios future HGV related emissions are forecast to increase. Freight operations form an essential part of the UK economy and HGVs are required to make essential deliveries to keep the economy moving and to supply the public with the goods that they need.

1.3 Changes to the modal split of transport of goods, improvements in fuel and engine efficiency, better route and load planning, including reduction in empty running, and other factors can all make contributions to reducing the carbon emissions from road freight and need to all be pursued.

1.4 The joint Government and Industry ‘Task Force on Low Emission Fuel Efficient HGV Technologies’ aims to promote the use and dissemination of technological solutions to reduce HGV emissions. The Task Force commissioned an initial report on opportunities to overcome the barriers to uptake of low emissions technologies for each commercial vehicle duty cycle. The report by Ricardo-AEA (hereafter Ricardo-AEA report on opportunities and barriers) defined five different HGV duty cycles and identified their respective share of overall HGV CO\(_2\) emissions\(^3\) as shown in figure 1.1.

\(^3\) Ricardo AEA, 2012 available from the Low CVP website: www.lowcvp.org.uk
1.5 Long-haul and regional delivery duty cycles combined accounted for by far the largest share of HGV emissions, around 70%.

1.6 The report then looked at the types of technologies including alternative fuels that could deliver the greatest CO₂ savings. For both long haul and regional delivery duty cycles gas engine⁴ technologies were identified as having the potential to deliver greater savings than other technologies considered.

1.7 Methane has the lowest direct CO₂ emissions per unit of energy of any hydrocarbon (in kg of CO₂ per KWh of energy), meaning that burning natural gas to propel a truck delivers emissions savings compared to burning diesel. However, these gains need to be balanced against the potential for increases in other greenhouse gas (GHG) emissions. The global warming potential of methane⁵ is significantly higher than that of CO₂ so even small quantities of methane escaping during storage, refuelling or combustion could negate the CO₂ emission savings on a GHG equivalent basis (see Methane Emissions at 3.36).

Air quality

1.8 Despite their small share in the total UK vehicle fleet, in 2011 HGVs contributed 23% of surface transport emissions of nitrogen oxides (NOₓ) emissions and 14% of surface transport emissions of particulate matter (PM)⁶. Air pollution in the UK from fine particulate matter alone is estimated to have a public health effect equivalent to 29,000 deaths each year as well as exacerbating long term health conditions. Diesel combustion in particular has significant health impacts.

1.9 Displacing diesel with gas is expected to help to deliver reductions in these emissions and therefore benefit air quality. Further work is necessary to develop emissions factors for gas and dual fuelled

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⁴ N.B. The term gas truck/ gas vehicle will be used as shorthand for any truck or engine that uses any form of methane gas as a fuel either exclusively or in combination with diesel.

⁵ The 2nd report of the International Panel on Climate change estimate the Global Warming Potential of methane to be 21times greater than that of CO₂. The 5th report has now revised that figure to 34.

⁶ 2011 National Atmospheric Emissions Inventory; figures for PM10 include non-exhaust emissions.
vehicles. Although the focus of this report is long haul and regional delivery cycles, establishing the infrastructure to support gas as an alternative fuel will provide opportunities for gasification of fleets outside long haul and into local deliveries in towns and cities where the impact of air pollution is greatest. This will help to support local measures and low emission strategies to promote gas vehicles.

Scope
1.10 This paper considers the use of gas as a fuel for HGVs. It recognises that various other measures need to be pursued and supported in parallel. Many carbon reduction technologies are complementary so that applying them alongside each other can deliver greater fuel and emission savings. The paper focuses on the two duty cycles which produce the largest share of emissions, and which tend to involve the heaviest and most powerful trucks and longer routes. Gas technology will also be beneficial for the urban delivery and municipal duty cycles which make a lower contribution to overall carbon emissions, but are more likely to operate in areas with air quality issues, for vehicles used in the construction duty cycle, and for buses (although the latter are outside of the Task Force’s scope).

Biodiesel
1.11 While biodiesel can deliver carbon savings, especially when produced from wastes, there are questions about the sustainability of biofuels produced from food-crops. Research has suggested that, when indirect emissions are taken into account, some biofuels can cause higher carbon emissions than fossil fuels. This report does not consider the contribution that biodiesel can make to reducing carbon emissions from freight operations but recognises that it will have a role to play, not least as many gas HGVs are dual fuel using both diesel and gas.

Hydrogen
1.12 The Committee on Climate Change (the CCC7) has set out its view that hydrogen fuel is the most likely and most effective option for reducing HGV emissions, in the longer term, from around 2030. It expects that advances in technology and investment in the required infrastructure will mean that by that time hydrogen fuelled HGVs will be a realistic and competitive option for fleet operators.8 However, there is no hydrogen technology available and viable for use in heavy trucks at this stage and most vehicle manufacturers do not see hydrogen as playing any significant role in powering heavy HGV duty cycles before 2050.9 The European Expert Group on Future Transport Fuels has also come to the

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7 The CCC is an independent body established under the Climate Change Act 2008 to advise the UK Government on reducing greenhouse gas emissions
8 COCC, April 2012
assessment that natural gas is one of the short/medium term options for reducing the use of oil as an energy source in transport, while hydrogen is seen as an option for the long-term.\textsuperscript{10}

1.13 However, the UK Bioenergy Strategy\textsuperscript{11} published by DfT, DECC and Defra in April 2012 stated that:

"In the long-term, our analysis shows that hydrogen may be used for heavy goods vehicles. However, the use of hydrogen in heavy vehicles is highly uncertain, due to the technical challenge of achieving the power densities in fuel cells necessary to make power-to-weight ratios and costs of these vehicles attractive. Whilst additional considerations, such as air quality regulations, might encourage the use of fuel cell heavy vehicles in niche applications, the feasibility of their wider deployment remains uncertain."

1.14 It is therefore important to consider and enable all viable, cost effective technologies which can contribute to reaching the 2050 carbon reduction targets. Increasing the use of methane in HGVs would not impede the introduction of hydrogen, if and when it becomes a viable fuel for HGVs.

1.15 This paper draws on the available information from research and stakeholders involved and interested in the production and use of gas HGVs and the supply of natural gas as a transport fuel to:

- Set out the current situation.
- Map out the approximate size of the challenge for HGVs to contribute to the Government’s carbon reduction targets.
- Consider the role that gas HGV could play in meeting these targets and the importance of lifecycle emissions related to different forms of gas fuels from different sources.
- Consider the challenges that would need to be addressed if there were to be a significant switch to using gas as a fuel for HGVs.

1.16 Wherever possible the paper draws on actual data and evidence related to the use of gas fuelled HGVs. However, it needs to be noted that such information, especially independent validation of monitoring, is relatively limited. The Low Carbon Truck Trials which will support the use of around 350 gas trucks over 2013-2015 and which includes independent evaluation of performance for all projects will be an extremely valuable source of information which need to be considered fully and disseminated once available.


\textsuperscript{11}https://www.gov.uk/government/publications/uk-bioenergy-strategy
The Rationale

Viability

1.17 Methane, from fossil sources or from renewable feedstocks, is one of the few viable alternative fuels which is already available to fleet operators.

1.18 Gas trucks, retrofit gas kits and refuelling facilities are all available on the UK market and delivering tangible CO₂ savings and have the potential, depending on a number of factors, to deliver cost savings over the vehicle’s first user life.

1.19 Gas technology has been explored by a number of operators as a cost effective way of reducing emissions. Several independent trials have been conducted in recent years. The Government’s technology neutral Low Carbon Truck Trial competition offered funding to projects that could deliver CO₂ savings of 15% or more; the vast majority of the bids for funding involved using gas fuel with just one project seeking to trial used cooking oil.

1.20 There are currently no viable alternative fuels other than methane that are market ready or deliver similar CO₂ reductions at similar cost effectiveness for use in regional delivery and long-distance heavy goods vehicles.

Environmental benefits

1.21 The Ricardo-AEA report on opportunities and barriers used previous research to estimate potential CO₂ savings for different technologies. The report recommends that further research is needed to clarify the CO₂ savings associated with different types, sources and supply of gas but the chart below (fig.1.2) gives an indication of the potential reductions in well to wheel carbon emissions that could be achieved using gas in long haul HGV operations. The chart also shows how these savings compare with other currently available technologies.

![Figure 1.2](image-url)

Data taken from the Ricardo-AEA report on Opportunities to overcome the barriers to uptake of low emissions technologies for each commercial vehicle duty cycle.
1.22 In some cases, potential carbon savings are shown as a range reflecting uncertainty of fuel efficiency of dedicated gas engines and also the variable well to wheel carbon emissions of LNG, which is considered further in Chapter 5 on the supply of gas. It should also be noted that there will be variability in emissions from CNG but for the purposes of this report CNG emissions were calculated using the 2012 DECC/Defra GHG Conversion Factors.

1.23 Figure 1.3 below shows the potential carbon savings identified in the report that may be achieved on regional delivery duty cycles. LNG was not considered as it was assumed that LNG would be most likely to be used for long haul operations where it may be difficult to provide sufficient CNG storage for the required vehicle range.
For trucks running purely on gas, and to a lesser extent for those running on gas and diesel, air quality improvement and noise reductions are significant.

The Coca-Cola Enterprises Biomethane Trial evaluated by Cenex in 2012 found that dedicated gas vehicle operations reduced NOx and PM emissions by 85.8% and 97.1% respectively compared with a diesel vehicle tested on the same duty cycle.\(^\text{13}\)

### Economic case

Trials and early adopters of gas-fuelled trucks have shown a viable business case for a fleet operator, whereby the cost premium over a standard truck can be recouped from fuel cost savings. The business case is dependent on a number of factors, but is expected to improve as the gas vehicle fleet increases and the refuelling infrastructure expands leading to economies of scale and reductions in costs.

DECC forecasts predict greater cost increase for diesel than for gas, which would improve the business case for replacing diesel as the main fuel with gas\(^\text{14}\).

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\(^\text{13}\) http://www.cenex.co.uk/consultancy/vehicle-deployment-trials/coca-cola-hgv-trial

\(^\text{14}\) DECC Fossil Fuel Price Projections December 2012.
1.29 Fleet operators and can meet their own ambitions for reducing emissions in a cost effective manner.

1.30 The UK is well placed to reap economic benefits from a growing gas truck sector. Two major providers of gas engine technology are UK companies with production sites in the UK.

1.31 A significant replacement of diesel with gas could lead to a reduction in oil imports. Globally, gas reserves exceed oil reserves. There is a significant domestic supply of feedstocks potentially available for the production of biomethane and more fossil gas may also be available through the exploitation of shale gas.

Summary

1.32 In order to maximise potential carbon reductions, efforts to increase the use of gas as an HGV fuel should be explored now. In the medium to longer term, it may be the case that technological advances will open up further avenues for significant carbon reductions for the HGV sector, but it is important to seize the existing opportunities both from a carbon perspective and where immediate local air quality benefits can be obtained.

1.33 Ensuring a shared commitment by the various players involved in the gas HGV market is important as there are interdependencies which mean that lack of progress by one player could slow down overall progress.

- Engine technology providers and vehicle manufacturers need to continue their R&D efforts to develop and market more efficient gas trucks, including the latest generation that can comply with Euro VI emissions regulations.
- A better network of public or shared access refuelling stations should encourage more operators to adopt gas HGVs and also enable the development of a second hand market for gas trucks as smaller operators who do not operate their own on base refuelling may see a business case for using gas trucks.
- Better resale value of gas trucks could improve the business case for first users to invest in gas trucks and lead to more compelling offerings of lease finance.
- Government while committed to being technology neutral in its support for transport carbon reductions, needs to ensure that regulation and policy do not present undue barriers to a greater roll out of gas fuelled HGVs.
2. Scenarios for a future gas HGV fleet

2.1 In some parts of the world the use of natural gas as a vehicle fuel is already quite popular and well established. This is usually where plentiful local supply means it is a cheap fuel.

2.2 Available data suggests the current UK gas truck fleet makes up an extremely small share of the overall fleet with the share post low-carbon truck trial reaching around 0.2% of the total fleet.\textsuperscript{15} Even very substantial carbon reductions for such a small share of the fleet will not make a significant impact on the overall carbon emissions from road freight.

2.3 However, when taking into consideration the picture across Europe and across the world, this makes the UK fleet one of the larger ones. Within Europe, Sweden is currently in the lead with 0.8% of its medium and heavy duty truck fleet running on gas, followed by Spain with just over 0.2% and with Italy, France, Iceland and the Netherlands having a share of below 0.2% of their fleets consisting of gas HGV. Worldwide the Ukraine stands out with a share of over 72% of its heavy and medium duty truck fleet gas fuelled, followed by Thailand where this share is just under 5%.\textsuperscript{16}

<table>
<thead>
<tr>
<th>Country (EU)</th>
<th>Total Natural Gas Vehicles</th>
<th>Medium Duty and Heavy Duty Gas Vehicles</th>
<th>M&amp;HD Gas vehicles as % of total M&amp;H D fleets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>41,789</td>
<td>627</td>
<td>0.79%</td>
</tr>
<tr>
<td>Spain</td>
<td>3,219</td>
<td>1,099</td>
<td>0.23%</td>
</tr>
<tr>
<td>France</td>
<td>13,300</td>
<td>900</td>
<td>0.16%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>5,201</td>
<td>230</td>
<td>0.14%</td>
</tr>
<tr>
<td>Italy</td>
<td>746,470</td>
<td>1,200</td>
<td>0.12%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>559</td>
<td>496</td>
<td>0.09%</td>
</tr>
<tr>
<td>Portugal</td>
<td>586</td>
<td>86</td>
<td>0.06%</td>
</tr>
<tr>
<td>Greece</td>
<td>526</td>
<td>108</td>
<td>0.04%</td>
</tr>
<tr>
<td>Slovakia</td>
<td>1,170</td>
<td>75</td>
<td>0.03%</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>3,964</td>
<td>41</td>
<td>0.02%</td>
</tr>
<tr>
<td>Austria</td>
<td>7,065</td>
<td>15</td>
<td>0.02%</td>
</tr>
<tr>
<td>Belgium</td>
<td>355</td>
<td>9</td>
<td>0.01%</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>61,256</td>
<td>20</td>
<td>0.01%</td>
</tr>
</tbody>
</table>

\textsuperscript{15} For a more details explanation and indication of data sources, please see chapter 3 on vehicles.
\textsuperscript{16} NGVA, Worldwide NGV statistics, 2012
<table>
<thead>
<tr>
<th>Country</th>
<th>NGV (Units)</th>
<th>Fuel (Units)</th>
<th>NGV Fueled (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>1,172</td>
<td>15</td>
<td>0.01%</td>
</tr>
<tr>
<td>Germany</td>
<td>95,162</td>
<td>145</td>
<td>0.01%</td>
</tr>
<tr>
<td>Denmark</td>
<td>14</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Estonia</td>
<td>191</td>
<td>3</td>
<td>0.00%</td>
</tr>
<tr>
<td>Hungary</td>
<td>372</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Ireland</td>
<td>1</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Latvia</td>
<td>18</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Lithuania</td>
<td>190</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>253</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Poland</td>
<td>2,094</td>
<td>4</td>
<td>0.00%</td>
</tr>
<tr>
<td>Slovenia</td>
<td>41</td>
<td>0</td>
<td>0.00%</td>
</tr>
</tbody>
</table>


2.4 There are various incentives in place which are likely to influence the level of uptake as well as other factors such national gas infrastructure and supply. Sweden has zero fuel tax on biomethane and financial support for some types of biomethane production units. Italy has a favourable tax regime with diesel taxed at 0.5932 €/l compared with 0.00331 €/Nm3. In 2012 some Spanish authorities offered grants of €12,000 for gas buses and lorries over 3.5t and grants of €30,000 for private refuelling stations or €60,000 for public refuelling stations.

2.5 The German Energy Agency ‘dena’ coordinates an initiative for natural gas-based mobility. The aim is to get a greater share of all vehicle types including passenger cars onto gas (mainly CNG) in part through a subsidised public refuelling infrastructure. The mobility initiative has a target to increase the share of biomethane in natural gas fuel to 20% by 2015, from its current share of around 15%.

2.6 The road freight sector will have to make a significant contribution towards meeting the 2050 target to reduce greenhouse gas emissions across the economy by 80%. Analysis from different sources, summarised in the box below, suggests that emissions reductions of over 60% up to 95% in HGV emissions could be consistent with meeting the 2050 target, and that reductions of this scale may be feasible, depending on future technology development.

### Box 2.1 Level of ambition for freight carbon reduction

A range of emissions reductions from road freight may be consistent with the 2050 Climate Change Act target depending on the potential for reductions across other sectors of the economy. The CCC have previously presented three scenarios for HGV emissions\(^\text{17}\) which suggest a range of emissions reductions from 63% to 96% are consistent with an overall 80% reduction in emissions (from 1990 levels).

\(^\text{17}\) Committee on Climate Change, The 2050 Target: achieving an 80% reduction including emissions from international aviation and shipping, 2012
In turn, the Logistics 2050 report\textsuperscript{18} showed that a 75\% reduction in HGV emissions could be feasible given a combination of actions to address operations, modal share, and low carbon technologies and fuels. Given the uncertainty around development of future technologies as well as future costs the Government’s Carbon Plan set out an approach to meeting the 2050 emissions target that took account of the uncertainties around future technology development through:

- supporting ‘safe bets’;
- acting to keep open different possibilities; and
- identifying and planning for decision points where possible paths diverge.

The logic of this approach is that action should be taken to pursue ambitious emissions reductions across sectors, and indeed transport modes, while uncertainty remains about the ability of future technology developments to deliver the reductions needed to meet the 2050 target. Keeping open the possibility of the higher end of emissions reductions is vital at this early stage to ensure that future decarbonisation options are not cut off.

Modelling for DfT’s Road Transport Forecasts 2013 suggests that in order to deliver reductions in road freight emissions that are consistent with meeting the 2050 target, significant additional action will be required beyond what is currently being undertaken. Under current action a 5\% improvement in fleet fuel efficiency is assumed between 2010 and 2015 on top of business as usual efficiency improvements of 0.5\% per annum. Underlying growth in HGV traffic, however, outweighs the improvements in efficiency in terms of overall emissions out to 2030.

### 2.7

This analysis is not designed to make the case for any particular avenue to reduce carbon emissions, but it shows the significant challenge of achieving carbon reductions for the HGV sector. This gives an important context to the consideration of increasing the gas HGV fleet - if switching HGV to gas is to have a significant effect then ambition is necessary in terms of switching significant numbers of trucks and encouraging the lowest carbon ways of running HGV on gas.

### Take-up scenarios

### 2.8

Arguably, the UK is at a critical stage in terms of deciding the future role of gas trucks in the HGV fleet. In the last few years, gas truck technology has advanced and become more widely available, a number of operator have introduced gas trucks into their fleets, more providers of gas fuel - both fossil and biomethane - have come to the market, the production of

\textsuperscript{18} A.C. McKinnon & M. I. Piecyk, Logistics 2050 Moving Freight by Road in a Very Low Carbon World, 2010
Biomethane is being incentivised and the Government-supported low carbon truck trial will increase the gas HGV fleet and refuelling infrastructure by 2015. Despite these favourable conditions, different scenarios for the development of the UK’s gas truck fleet up to 2030 are currently conceivable.

- **Low take-up:** If none of the parameters that currently influence HGV fleet operators in making decisions about their fleet and individual carbon reduction ambitions change, then it is likely that the gas fleet will not increase significantly beyond its current size. Gas trucks would remain the preferred choice only for part of the fleet for a small number of larger operators, rather than becoming a mainstream option.

- **Medium take-up:** A medium take-up scenario might see those operators currently trialing gas vehicles expanding their fleets and uptake by other operators. In 2012, 23,000 new HGVs over 18t were registered. Based on this figure, if 5% of new HGVs from 2014 onwards are gas vehicles, then assuming new vehicle registrations remain constant (and vehicles reaching the end of their life are replaced in addition), this would equate to 20,000 gas vehicles by 2030, equivalent to 10% of HGVs over 18t in 2012.

- **High take-up:** this scenario might see all HGVs on long haul and regional delivery duty cycles using gas by 2030. This would be very challenging, requiring nationwide refuelling infrastructure and a well-established second hand market.

**Factors influencing the likely development of the gas truck fleet**

2.9 Major factors influencing the trajectory going forward are related to the cost of natural gas compared to diesel; this will be dependent partly on global developments of supply and demand of oil and gas and related costs, as well as the domestic tax and duty regime. The development of a greater domestic supply of biomethane and crucially its availability for use as a transport fuel are related to this. Mandatory carbon reduction targets or related regulations may also favour an expansion of the use of gas as an HGV fuel if this provides a cost effective way of complying.

2.10 Furthermore, initiatives and regulations originating from the EU will influence take-up in the UK: the 2013 Clean Power for Transport package includes measures to boost the infrastructure for gas as a transport fuel and the 4-year EU LNG Blue Corridors project will build LNG refuelling stations for heavy duty HGV across four major European transport corridors, and run demonstration trucks on these routes linking up with national projects. The revised Renewable Energy Directive is likely to improve the incentives for use of biomethane as a transport fuel.

2.11 The makeup of the HGV parc in Britain will also influence the trajectory. The latest statistics show 352 operators run fleets of more than 101

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trucks each. It is mainly these larger operators for whom adopting gas HGV currently presents a cost effective business decision. They tend to have specific carbon reduction and sustainability targets and commitments, which are important in their relationship with their customers and to secure contracts. They also tend to operate on less tight margins than the smaller operators and have the scope to invest in technology that may have a payback period of several years. As first users of HGV they have access to the latest gas technology either retrofitted or integrated into a new truck, which deliver the greatest gas substitution and they will be able to benefit from economies of scale meaning that investing in an on-base refuelling facility may be cost effective.

2.12 At the other end of the spectrum 50% of operators use just one truck each, accounting for another 44,000 vehicles within the total HGV parc. This element of the fleet is less likely to switch to gas in the near future. It often consists of older vehicles, which may have had several previous users and which will be harder to convert to gas/dual fuel with a return on investment before the end of the vehicle’s life. Gas truck technology will only reach this part of the fleet once it is available on the second-hand market and there is widespread access to public-access or shared refuelling infrastructure.
3. Vehicles

3.1 The types of trucks that operate on long-haul and regional delivery duty cycles tend to be among the larger trucks, with a mix of rigids and articulated trucks. Trucks on these two duty cycles are estimated to use around 70% of HGV fuel and consequently produce around 70% of total HGV emissions. Regional delivery sees a mix of rigids typically 18 -26 tonnes and artics over 30 tonnes, while the long haul duty cycle is mainly covered by 33-44 tonnes artics and some rigids up to 26 tonnes\(^\text{20}\). Vehicle manufacturers suggest that many fleet operators prefer to use larger vehicles with greater horse power than they need for their day to day operations in order to have greater flexibility.

3.2 Around 30% of the fleet of around 460,000 licensed British HGV consists of vehicles over 31 tonnes and nearly a third (13,700) of new HGV registrations in 2012 were for HGV of over 41 tonnes. Articulated HGV over 33 tonnes move 75% of goods (weight of freight multiplied by distance travelled)\(^\text{21}\). 98.9% of the truck fleet run on diesel in compression ignition engines.

UK gas HGV fleet

3.3 There are no fully comprehensive statistics about the number of gas trucks currently in use in the UK. This is partly due to the fact that many of them will be post-registration conversions. The Natural and Bio-Gas Vehicle Association (NGVA) estimates that there were 496 medium and heavy duty post-registration converted gas trucks in use in the UK, equivalent to 0.09% of the overall parc, in 2011. The Society of Motor Manufacturers and Traders’ (SMMT) 2012 Motorparc statistics show 300 gas vehicles, though this it thought not to include post-registration conversions. A large proportion of these are being used as part of trials to assess performance and costs compared to conventional diesel trucks.

Vehicle Special Orders

3.4 The Vehicle Certification Agency (VCA) issues individual Vehicle Special Orders (VSOs) for vehicles run on LNG and shows nearly 300 new registrations over the 12 months to May 2013. Individual orders are not required for CNG vehicles so there are no equivalent figures.

3.5 It is intended that regulations will be made to remove the need for individual VSOs for HGVs using LNG. This will reduce the burden on both industry and Government.

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\(^{20}\) For more detail on the duty cycles please see Ricardo-AEA, December 2012

\(^{21}\) DfT Statistics, Vehicle Licensing Statistics, Tables VEH0507, VEH0556; Road Freight statistics, Table RFS0107
Low Carbon Truck Trials

3.6 The low carbon truck trial, providing Government funding to support low carbon trucks (CO2 emission at least 15% lower than for comparable diesel truck) and their supporting infrastructure will increase the gas HGV fleet by around 350 gas HGVs in total over the trial period from 2013 to 2015. Some of these vehicles are already on the road so will be included in the VCA special orders number. The majority of projects involve dual fuel HGV using natural gas (both liquefied or compressed) in a compression ignition engine alongside diesel with the option of reverting to running purely on diesel should a gas supply be unavailable. Only one project is looking to trial dedicated gas trucks. This is in line with the makeup of the existing gas HGV fleet in Britain, where the majority of trucks currently use dual-fuel compression ignition engines.

3.7 Assuming no further increase in the gas truck fleet beyond the projects in the pipeline, gas trucks would only make up around 0.2% of the total fleet by 2015.

Dual fuel HGVs

3.8 Dual fuel HGVs use both diesel and gas and dominate the current gas HGV fleet. Fleet operators and manufacturers report substitution rates of gas for diesel of at most around 50-60% but this will vary over the drive cycle, with the smoother driving modes often associated with long-haul routes allowing for greater substitution. Dual fuel vehicles can run on diesel alone which means the vehicle can still operate if gas is unavailable.

3.9 A number of technology producers offer ready-made conversion or retrofit technology kits that are compatible with a number of main brand HGV models. HGV manufacturers tend to have several HGV models that are designed to work with conversion kits. They can normally be combined with either LNG or CNG tanks depending on the operator’s preference.

3.10 LNG and CNG are different forms of natural gas with the liquefied form offering greater energy density. Therefore gas engines can run on both forms but require different storage tanks. Tanks for liquefied natural gas are more expensive as they require vacuum insulation and pressurisation, but due to the greater energy values per volume LNG allows a greater vehicle range for a smaller tank and is therefore preferred where longer routes are covered without a return to base. The range of dual fuel HGVs varies according to the substitution rate and other factors but it is in the region of 500 kilometres when LNG is used and around half that for CNG. Articulated tractor/trailer combinations lend themselves to LNG use due to limited chassis space for tanks.

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22 This report uses the term dual fuel truck for HGV that run on a mix of natural gas (methane) and diesel in a compression ignition engine, but can run purely on diesel. 'Bi-fuel' vehicles can run on two different types of fuel, and tend to be based on petrol spark ignition engines adapted to use either petrol or gas, one at a time rather than a mix. The bi-fuel concept is mainly sued in vans and cars rather than heavier trucks.
whereas rigid vehicles typically 7.5 to 26 tonnes lend themselves to CNG due to adequate chassis space for larger tanks.

**Dedicated gas engines**

3.11 Dedicated gas engines are based on a spark ignition petrol engine. They run purely on gas with no option to draw on an alternative petrol supply should the gas supply run out. Whilst these trucks clearly achieve 100% substitution of conventional fuel with gas, their overall fuel use performance is influenced by the inherently less efficient spark ignition engine. The most powerful dedicated gas truck currently available has 330 bhp, and a Gross Vehicle Weight of 26 to 28 tonnes, so is not currently an option for the heavier end of heavy duty functions.

**Technology manufacturers**

3.12 Dual-fuel gas technology can also be factory fitted into the truck and these models are referred to as OEM - original equipment manufacturer models, as they involve collaboration between gas technology producers and the original truck manufacturer. Currently on the UK market, there is one dual fuel model by Volvo with integrated Clean Air Power gas technology. It is considered that OEM models offer better integrated technology enabling greater efficiency and higher gas substitution rates, with manufacturers quoting rates of 60-80% or even up to 90%, again with variability over the drive cycle. OEM gas trucks also have the advantage of falling under manufacturer warranties and service support. However, some truck manufacturers offer a letter of non-objection from the OEM which means the warranty can be maintained when retrofitted with approved gas technology.

3.13 There are a number of companies who manufacture gas HGV engine technology and/or convert standard diesel HGVs including several UK companies such as Clean Air Power Ltd, the Hardstaff Group and G-volution.

3.14 Other gas engine providers include Prins autogas and Westport Innovations Inc. (although the latter is based in Canada and its technology is not yet available on the UK market).

**Confidence in gas trucks**

3.15 Large fleet operators tend to have long-standing agreements with manufacturers for the supply (mainly through operational or financial leases) of trucks and associated maintenance contracts. This could include a number of different manufactures for different elements of their fleet. Anecdotal evidence suggests that these operators therefore tend to prefer to work with their existing manufacturer when using gas fuelled HGVs giving them confidence in the reliability and quality of the product and support service. This would suggest that more of the major truck manufacturers bringing their own OEM models onto the UK market could accelerate the expansion of the dual fuel fleet with the highest substitution rates.

3.16 Anecdotal evidence from fleet operators using gas HGVs suggests that there is little difference in performance and reliability between gas trucks
and conventional diesel trucks, with some reporting that drivers rate some aspects of performance more highly than for diesel vehicles, including e.g. engine noise and refuelling.

3.17 More detailed surveys on driver opinions and experiences will be available through the Low Carbon Truck Trial Evaluation.

Costs of gas HGVs

3.18 Operators have reported the cost premium of a dual fuel HGV over the comparable diesel HGV to range from £15,000 to £44,000. The cost is influenced by a number of factors including the type of gas used (LNG vehicles are more expensive than the CNG equivalent due to the cryogenic tank specification) and whether a methane catalyst has been included in the conversion. This technology can be expensive but reduces methane slip, an important factor in the overall greenhouse gas emissions of the vehicle (see paragraph 3.36 below).

3.19 Some stakeholders have expressed a view that as greater volumes of gas HGVs are produced for the UK market the price premium may reduce.

3.20 The current lack of a second hand market for gas trucks means that the gas technology does not add to the residual value of the truck, and in fact the technology tends to get removed so the truck reverts back to running on diesel for its next use. This means that an operating lease, where the lease costs are based on the differential between purchase price and residual value does not present good value for money as the finance model for the first user. As open access gas refuelling becomes available in the UK, operating a second-hand gas truck will become a viable option for smaller operators, where they are located or operate on routes within easy access of the sites. The emergence of this second hand market should therefore have a positive effect on the business case of first operators.

3.21 The FTA states that the expected work life of a tractor unit is normally 6 to 7 years and that first users normally keep their HGV for a period of 5.1 to 6 years. Anecdotal evidence from operators suggests that they may keep a gas HGV for slightly longer to ensure additional capital costs are recouped from fuel savings.

Running costs

3.22 Anecdotal evidence from users of gas trucks suggests additional maintenance costs might be between 10% - 40% higher than for conventional trucks and maintenance costs may be higher the higher the gas to diesel substitution rate. Some operators have provided information on additional maintenance costs of their dual fuel gas trucks at £750, £1,000, £1,400 and £3,800. Other costs arising from the use of gas vehicles include new injectors with one operator reporting costs for these at £2,000 every 5 years. Fuller data about running costs is expected to become available from the low carbon truck trial.
3.23 Maintenance costs may reduce as the number of gas HGVs grows and the availability of engineers familiar with gas engines increases.

Regulatory issues

3.24 The Road Vehicles (Construction and Use) Regulations do not allow for the use of any gas fuels other than LPG. This means that the current fleet of gas fuelled HGVs is approved through vehicle special orders. A general order permits the construction and use of vehicles using CNG but individual orders are required for vehicles running on LNG. Vehicles operating on special orders are exempted from annual testing requirements. As the current fleet is small this has not been a problem but as numbers increase it will be necessary to remove the need for special orders to maintain roadworthiness and reduce burdens on industry and Government.

3.25 Gaining type approval for new OEM gas and dual fuel trucks is also a requirement for them to be registered in the EU. This is dependent on compliance with European emissions standards which set limits for the amount of nitrogen oxides (NOx), particulate matter (PM), and hydrocarbons (HC) emitted. Because it was recognised that it would be difficult and expensive for dual fuel gas engines to meet the latest Euro VI standard, which has applied to all heavy good s vehicles registered since the beginning of 2014, appropriate emission limit values and test procedures for them have been set in Regulation EU 133/2014, which amends the basic Euro VI Regulation. EU 595/2009.

3.26 Euro VI diesel trucks will be more expensive than equivalent Euro V diesel trucks and in some cases there may be a fuel consumption penalty with the technology required to ensure compliance with stricter emissions standards. For trucks selective catalytic reduction (SCR) is used to control NOx emissions. SCR uses a catalyst to convert NOx into nitrogen and water vapour, but requires the use of a urea reagent (sold as “adblue”) which is injected into the exhaust system.

3.27 Manufacturers have often developed other fuel saving innovations which compensate for the engine’s increased fuel use. It may be the case that this development reduces the cost differential between dual fuel trucks vis-à-vis standard diesel trucks, which for the newest HGVs could reduce the payback period of gas technology.

Compressed or liquefied gas

3.28 For operators looking to introduce methane into their fleets and important consideration is whether to use compressed or liquefied gas. Natural gas at ambient temperature and pressure has a much lower energy density than diesel, so in order to store and use it as an HGV fuel, it is either compressed (to 300 bar pressure and dispensed at 250 bar pressure), turning it into CNG, or cooled to -160°C to turn it into a cryogenic liquid, LNG. A standard fuel tanker can hold around 6 tonnes of CNG or 20 tonnes of LNG.

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23 The LowCVP, Biomethane in transport HGV cost modelling report assumes that cost will be around 5% higher. TTR, Joule Vert, TRL, October 2011
3.29 CNG has an energy density of only 25% that of diesel whereas LNG has about 60% the energy density of diesel and therefore provides a longer range for HGVs. Tractor units used in combination with semi-trailers, normally in the 38-44 tonnes range, lend themselves to LNG due to the very limited space to locate tanks. However, LNG requires a vacuum insulated fuel storage tank and needs to be used within 48 hours of filling whereas CNG can be stored indefinitely.

3.30 CNG can be drawn directly from the gas grid whereas LNG must be transported by road tanker to a refuelling station.

Carbon performance

3.31 In terms of the carbon performance of different types of gas trucks there is a lack of consistent independently verified information, beyond individual vehicle trials\(^{24}\). Potential sources of further data may include:

- Evaluation data from the Low Carbon Truck trial projects (final report due December 2015 but interim findings may be available earlier);

- The Centre for Sustainable Road Freight (a collaboration between Cambridge and Heriot-Watt Universities with industry consortium members) is working on a research project on alternative fuels - this will include quantifying the carbon intensity of diesel fuel alternatives for HGVs and evaluating tailpipe emissions in dual-fuel operations.

- Gasrec ‘pilot study’ to test the use of Bio-LNG with HGV fleet operators already operating natural gas powered vehicles in the UK\(^{25}\).

3.32 Vehicle and technology manufacturers emphasise the best possible CO\(_2\) reductions achievable, however these may not be deliverable over the full drive cycle but apply to smooth driving modes.

3.33 As set out in Chapter 1, the carbon performance of gas vehicles is thought to range from 11% more carbon emissions than diesel equivalents to reductions of around 65%. Carbon performance depends on vehicle type, duty cycle, gas substitution rate achieve and, most significantly, the source of gas. As discussed in more detail in Chapter 5 below, for any vehicle the use of biomethane - whether in a dedicated gas engine or in a dual fuel engine and whether liquefied or compressed - rather than natural gas will always deliver much lower CO\(_2\) emissions, when the fuel pathways from well to wheel is taken into account, as biomethane is a renewable fuel.

3.34 However, it is desirable to minimise overall fuel consumption and thereby tailpipe emissions of CO\(_2\) and other greenhouse gases, as well

\(^{24}\) For an example of a trial comparing a dedicated gas truck with a similar diesel truck that was monitored and evaluated in terms of the carbon and air quality performance as well as other factors such as reliability, driver satisfaction etc, please see the Coca-Cola Ltd trial report produced by Cenex. www.Cenex.co.uk

\(^{25}\) http://gasrec.co.uk/eu-funding-for-gasrec-to-help-hgvs-cut-fuel-pollution-and-costs/
as pollutants such as NOx, PM and hydrocarbons, rather than simply aim to replace as much conventional fuel as possible with biomethane.

3.35 Biomethane used in a dedicated gas truck can deliver even greater well-to-wheel savings, of up to 65%, it is worth noting that a spark ignition dedicated gas engine is inherently less efficient than a diesel engine leading to greater fuel use so overall carbon performance should be considered. The most efficient engine type and vehicle for the duty cycle in question should be chosen alongside the lowest carbon fuel.

Methane emissions

3.36 An important issue to consider is that of unburned methane emitted from the tailpipe, referred to as methane slip. Even a very small amount escaping can have a significant negative impact in terms of real CO₂ equivalent emissions as the global warming potential of methane is significantly higher than that of CO₂. There are technical solutions to minimise this issue: some operators are using methane catalysts (at a cost of around £5,000) in their HGVs to convert the unburned methane into CO₂ and water.

3.37 There is little data on the issue of methane slip. The Low Carbon Truck Trials will measure methane emissions from the different technologies being trialled. It will be necessary to consider this and any other data available to determine how efficient methane catalysts are, whether they are required in all circumstance and how, where their used is deemed necessary, this can be ensured.

3.38 Venting of LNG from vehicle fuel tanks has also been identified as potentially impacting on greenhouse gas emissions.

Air Quality

Dual fuel vehicles

3.39 The emissions from dual fuel methane/diesel vehicles are currently poorly characterised. These vehicles are predominantly after-market conversions, rather than original builds, and there is very little published emissions data. Therefore it is difficult to assess their air quality benefits without further information. Any reduction in air pollution will be dependent on the diesel / gas substitution rate.

3.40 A report by the National Society for Clean Air and Environmental Protection²⁶ suggests that dual fuel trucks can yield significant reductions in particulate emissions.

²⁶ National Society for Clean Air and Environmental Protection, Biogas as a road transport fuel, 2006
**Dedicated gas vehicles**

3.41 For dedicated gas vehicles, PM emissions meet at least Euro VI standards while emissions of nitrogen oxides (including nitrogen dioxide) without any emissions abatement technology are generally around, or slightly above, the 2009 (Euro V) standard and generally similar in emission performance to that of a conventional Euro V diesel vehicle. However, when fitted with three-way catalyst emissions abatement technology which is common in petrol fuelled passenger cars, the emissions of nitrogen oxides become below those required by the current (Euro VI) standard. These vehicles will therefore emit lower NOx than conventional diesel vehicles.

3.42 One trial of a dedicated spark ignition HGVs reported air quality benefits of around 80% reduction in nitrogen oxides and a 100% reduction in particulate matter.27

3.43 The Low Carbon Truck Trials will evaluate NOx and PM emissions from a range of vehicles.

**Noise**

3.44 Data is available for noise reduction for a dedicated gas truck compared to an equivalent diesel truck from the Cenex Coca Cola Enterprise Ltd/Scania truck trial showing significant noise reductions of between 4.1 and 10.5 decibel(A), for different drive mode. For dual fuel trucks the noise reduction is thought to be less, around 3 db(A).

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27 See for example Cenex Coca Cola Enterprises Ltd biomethane vehicle trial.
4. Refuelling infrastructure

4.1 The existing infrastructure across the UK for natural gas or biomethane refuelling is relatively sparse and consists of a small number of public or shared access stations and a larger number of private on-base stations which are used only by one fleet operator. Operators tend to have a preference for either liquefied or compressed gas, depending on their location (CNG use normally requires access to the gas grid), operations and routes including return to base frequency, therefore infrastructure for both LNG/LBM and CNG/CBM refuelling is required.

4.2 Larger operators tend to use their own on base refuelling stations for diesel (and petrol). These are generally supplied by a fuel provider through longer term contracts and tend to offer more competitive prices than at the pump. For such operators looking to use methane it is often critical that refuelling can also happen on base in a similar way as their conventional refuelling. However, a better public refuelling infrastructure would also allow those operators who generally refuel at base to increase payload or cover longer distances without additional on-vehicle fuel storage at the expense of reduced payload.

Liquefied Natural Gas (LNG)

4.3 LNG trucks tend to be used for long haul routes as a tank load provides a range of around 500 km. It is produced by bringing natural gas to very low temperatures (-162°C) until it becomes a cryogenic liquid. LNG has much higher energy per volume, compared to natural gas at ambient temperature or to compressed natural gas. It can be contained in a tank under the chassis like a diesel tank, but the tank is 10% larger than a diesel tank because of the cryogenic skin. In this way it gives the vehicle range without compromising payload significantly. Providers who specialise in the provision of LNG deliver the gas by road tanker to their customers, or to public or shared access filling stations. Chive Fuels Ltd., BOC Industrial Gases, Hardstaff Group (and others) supply LNG alongside providing storage and dispensing equipment or sophisticated refuelling stations so their customers can set up their own refuelling facility on base.

4.4 Currently, there is only one LNG terminal with the facility to load road tankers with LNG for distribution to LNG stations at Avonmouth. This facility was disrupted during 2013 meaning that for a period, LNG had to be imported by road tanker to refuel LNG stations. However there are plans to develop an LNG loading service for road tankers at Grain.
LNG refuelling

4.5 Gas suppliers have suggested that storage and dispensing equipment is available which can provide safe and flexible refuelling on base, even for a non-permanent set-up, for example as part of a trial. Due to its greater energy density compared to compressed gas, transporting liquefied natural gas by road tanker can be an efficient option if the distance from the gas production or processing site is short. Gas suppliers and users enter into contracts covering several years for the supply of gas at a certain price, and provision and maintenance of the refuelling equipment.

4.6 There are many more on-base LNG stations located at major operators’ depots and only a small number of public or shared access sites. Shared access sites may offer a cost effective solution in certain circumstances for example at strategic points where several fleet operators are located within close proximity. Use by several different parties requires some particular provisions in terms of security and safety, for example requiring all potential users to be trained if the station is unmanned. The location is also critical as operators need to avoid any detours from their routes as much as possible to meet delivery and turnaround times and minimise fuel consumption.

4.7 LNG stations can be located more flexibly in line with demand as they are supplied by road tanker and are not dependent on gas grid access. Where open access refuelling stations and private ones on a customer base are co-located, efficiencies can be gained.

Compressed Natural Gas (CNG)

4.8 A tank load of CNG provides a range of around 250 km. CNG is natural gas which has been compressed for use as a truck fuel to around 250 bar pressure. The most efficient provision of CNG as a vehicle fuel tends to be through further compression of gas drawn from the gas grid.

CNG refuelling

4.9 Gas from the local transmission system of the gas grid, where it has a pressure of around 10 - 40 bar, can be transported by pipeline to a nearby strategic location to supply a refuelling station. At that point the gas is further compressed to levels needed for HGVs. This process is very energy intensive – the station needs to operate at 300 bar in order to deliver fuel at 250bar and needs to be capable of delivering up to 600kg of fuel per hour per dispenser. The compressed gas can then be stored at high pressure and dispensed to trucks. A large grid-supplied CNG filling station with capacity to fill dozens of large trucks quickly (in around the same time as refuelling them with diesel would take) costs around £500,000.

4.10 The transport of CNG by road tanker is not an efficient way of distributing it due to its lower energy density.
Biomethane

4.11 If fleet operators want to use compressed biomethane or a blend of compressed natural gas and biomethane, they have the option of buying and storing Liquefied Biomethane at their site and converting it to CNG for dispensing and use. At points where access to the local transmission system is possible within close proximity of the desired location of a refuelling station a CNG station supplied by pipeline from the gas grid can be an effective solution.

4.12 Gasrec offer a similar service and are able to provide LBM or their blend of LNG with biomethane offering greater carbon reductions.

Refuelling infrastructure costs

<table>
<thead>
<tr>
<th>Box4.1 Low CVP cost modelling - impact of refuelling options on costs</th>
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<tbody>
<tr>
<td>A study carried out for the LowCVP(^{28}) has modelled the costs related to using biomethane as a truck fuel, including the break even times for operators for different refuelling options. The study concluded that generally larger refuelling stations with capacity of 5,000 to 10,000 kg of gas per day - to fuel 25-50 or 50-100 trucks respectively per day - can provide CNG or LNG at prices that can compete with diesel and are therefore likely to be required for a viable business case.</td>
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The cost model shows that the break-even point at which the additional capital costs related to the vehicle and infrastructure are recouped through fuel cost savings comes considerably quicker for those operators who have access to gas from a larger capacity refuelling station. This is true both for dedicated and for dual fuel trucks and for LNG and CNG.

The study further considers the case for a smaller operator running just 5 HGV and shows that buying gas from a larger refuelling station offers cost savings over the assumed vehicle first user life time of 5-6 years, while the installation of a small on-base refuelling station would not be a viable business decision.

4.13 Refuelling infrastructure costs will also be influenced by the availability of land for depot-based refuelling.

Existing and future refuelling infrastructure

4.14 The Royal Borough of Greenwich council, in partnership with the Transport Knowledge Transfer Network and some other organisations, has set up the Gas Vehicle Hub\(^{29}\), a dedicated website which provides a


\(^{29}\) www.gasvehiclehub.org
comprehensive map of existing refuelling infrastructure. It includes stations that will be set up as part of the Low Carbon Truck Trial.

4.15 In addition, some gas fuel suppliers have published their own plans to extend their network of stations in the near future. The first public access bio-LNG station opened by Gasrec last year at DIRFT has capacity for refuelling up to 250 trucks per day, but with plans to increase that capacity to around 700 vehicles per day. Gasrec has plans to build out a national open access refuelling network in the next two years. The speed and order of location selection of roll out will be determined by customer demand. Gasrec has TEN-T grants towards the construction of open access refuelling stations in Avonmouth, Livingston, Thurrock and Wakefield. With DIRFT, this network will allow an HGV to reach 85% of the UK population within four hours’ driving time. The network will have initial throughput capacity to service 1,250 HGVs per day. The stations will be modular which will enable them to be scaled to be able to service over 6,200 HGVs daily according to demand.

4.16 The FTA has carried out a survey of its members with 17 of them providing their views of desired locations of refuelling stations. This exercise has enabled the mapping of 20 locations across strategic points on or close to the motorway network in England. Most of these sites have some current gas provision with exceptions at Lichfield, Huntingdon and Coventry.

4.17 Other factors such as the location of logistics hubs, and of existing private refuelling stations are also relevant. It is likely that a national network for LNG is more crucial given its predominant use for fuelling long haul operations, while for regional delivery duties using CNG a convenient regional CNG network will be more important. At the same time, for operators with a small number of trucks in their fleet a strategically located public refuelling infrastructure is likely to be a prerequisite to making the use of gas trucks viable.

Clean Power for Transport proposals

4.18 The European Commission policy package published in January 2013 on Clean Power for Transport, included a proposal for a Directive on the deployment of alternative fuels infrastructure with binding targets for the deployment of both LNG and CNG infrastructure within Member States.. The proposal sets a maximum distance of 150km between CNG stations and 400km between LNG stations on the TEN-T network across Europe by 2020.

4.19 The DfT carried out a high level consultation on the proposals in 2013. Stakeholders were not convinced that the deployment of gas refuelling infrastructure based on geographical proximity would establish a suitable network in an efficient and cost effective manner, relative to market demands.

4.20 Negotiations on the draft Directive continue between the European Institutions with an ambitious objective of reaching an agreement in March 2014.
Planning consent for new refuelling stations

4.21 Some gas fuel suppliers have indicated that the process for gaining the necessary consents for building a new refuelling station can vary between different local authorities and can in some cases be lengthy, to the extent that for some projects it can cause undue delays. They have indicated that some or all of the following consents are required, depending among others, on the types and quantities of gas (and other hazardous substances) stored at the site, and the type of site:

- Planning Permission, which may involve consultation of a number of statutory consultees and may require the consents below. The height of fuel tanks can be a difficult issue in gaining consent;
- Hazardous Substance Consent, which is expected to take 8 weeks but has been reported to take significantly longer;
- compliance with the Control of Major Accident Hazard (COMAH) Regulations which are enforced jointly by the Health Safety Executive (HSE), the Environment Agency (EA - for England and Wales) and the Scottish Environmental Protection Agency (SEPA);
- Advertising Consent, which is required only where relevant for an open access station; and
- Landlord Consent, which is only required where relevant for customer sites.

4.22 For CNG stations with less than 2-3 tonnes of gas storage, which is within the typical quantities, COMAH regulations do not tend to apply, and for a new station on an operator’s depot where there is already a diesel station and therefore no change to operations is involved, planning consent may not be required.

Safety and emissions standards

4.23 It is important that all storage and refuelling facilities, including private ones at an individual operator’s depot adhere to strict safety and technical standards. The consents noted above are aimed at minimising safety and accident risks but standards should also be set related to the quality standards required, for example related to greenhouse gas emissions from the escape or venting of methane. Methane traps or catalysts of certain standard must be required to ensure a level playing field for providers of storage and refuelling solutions.

4.24 Given that the global warming potential of methane is much higher than that of CO₂ even small quantities of methane escaping during storage or refuelling could negate the emissions savings achieved by replacing some diesel with gas fuel. For liquefied gas, venting can be a particular issue if it is stored without being used or the storage container being refilled, as it is subject to thermal evaporation, or boil-off. Gas fuel providers have developed solutions to tackle the problem of methane venting. One supplier uses nitrogen to control the temperature of the cryogenic liquid and prevent boil-off. A solution available for stations providing liquefied and compressed natural gas alongside each other
whereby boil-off from liquefied methane is captured and stored for use as CNG.

4.25 The EU’s Clean Power for Transport proposals and draft directive contain technical specifications and reference to standards and regulations – some yet to be adopted – that will need to be adhered to regards the storage and refuelling points for both CNG and LNG. Binding standards for refuelling and storage of gas fuels at national and/or EU level are important to minimise adverse emissions effects and ensure a level playing field between fuel providers.
5. Supply of methane and biomethane

Natural gas and biomethane pathways

5.1 There are many different pathways to getting methane from source (whether fossil or renewable) to its final state ready for use in an HGV. Each of these will have an impact on the carbon emissions. When the whole pathways of the fuel from well to wheel is considered, savings from using natural gas can be significant, and notably exceed the savings achievable through other currently available technological improvements.

5.2 Much more significant savings can be achieved if biomethane from sustainable sources is used instead of natural gas: 42% and 35% respectively for long-haul and regional delivery operations in a dual fuel vehicle. Biomethane used in a dedicated gas truck can deliver even greater well-to-wheel savings, of up to 65%.

5.3 Biomethane is chemically identical to its fossil equivalent, so it can be used in the same engines without any adverse effects and can also be blended in any proportion with natural gas. The greater emissions savings achievable from use of biomethane point firmly towards aiming to increase the share of biomethane as a truck fuel. However given the much greater current availability of fossil gas it is likely to be the predominant source of methane in the short to medium term until the supply of biomethane for use as a road fuel increases.

5.4 If using fossil natural gas - without any significant share of biomethane - the well-to-tank pathway to the point of use is then particularly relevant to find the most carbon efficient option. This will include consideration of the energy required to process the gas to make it available to be used as a vehicle fuel, the distance over which the gas is transported to get to the vehicle and the energy used to transport it. However, these considerations are also relevant for the use of biomethane. Some of the carbon reduction benefits associated with biomethane could be negated if the gas is transported over long distances to its point of use. See Appendix 1 for illustrations of the pathways for producing and supplying natural gas and biomethane.
UK natural gas supply

5.5 Currently the UK’s natural gas supply is made up of a mix of domestic supply and imports. In 2012, domestic supply covered around half of the UK’s demand for gas, and the remainder of demand was met by imports. By 2030 the UK will require up to 28GW of new gas plant, in part to replace coal, gas and nuclear plant as it retires off the system. As the UK transitions to a low carbon economy, and with a decline in domestic oil and gas production, the UK will become increasingly reliant on imported energy.

5.6 These scenarios will also influence future gas prices which, together with the differential between gas and diesel prices will also impact on the balance of costs and benefits of using gas HGVs. Most official projections tend to anticipate a greater increase in diesel prices than gas prices based on greater global gas reserves compared to oil reserves, including new unconventional gas supplies such as shale gas.

Figure 5.1 DECC Energy Price Projections

<table>
<thead>
<tr>
<th>Year</th>
<th>Price</th>
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<tr>
<td>2014</td>
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<td>2016</td>
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<td>2018</td>
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5.7 However, to secure the greatest potential carbon savings it is important that biomethane replaces natural gas in HGVs as early as possible.

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Biomethane

5.8 Biomethane can be produced from a variety of feedstocks and has been developed and encouraged as a new and renewable energy source over recent years.

5.9 The Government has committed to promote an increase in the generation of energy from waste through anaerobic digestion and a strategy with actions to achieve this has been published although there is a finite amount of typical feedstock of AD and Government is not looking to increase AD from crops.

5.10 Evidence from some large fleet operators suggests that there is significant demand for biomethane as a HGV fuel in order to deliver the greatest carbon reductions for their fleets.

Biomethane from landfill

5.11 The only biomethane currently used directly in HGVs is produced from landfill biogas which is upgraded and then supplied to refuelling stations by road tanker. Supply is limited, with just one provider in the country, Gasrec, offering Bio-LNG, a blend of liquefied biomethane (ranging from 15% - 25%) and conventional LNG through its public refuelling station at DIRFT and direct to operators with private refuelling facilities. Biogas from landfill has a typical methane content between 50 and 55% and contains more contaminants due to the mixed feed stocks contained in landfill waste. Biomethane produced from landfill gas is not injected into the national grid therefore is does not qualify got for the Renewable Heat Incentive. Landfill biogas is a declining resource due to stricter waste management policies aimed at avoidance of landfill. For this reason, most projections of future biomethane resource look at anticipated levels from anaerobic digestion plants.

Biomethane from anaerobic digestion (AD)

5.12 Biogas from anaerobic digestion consists of around 60% to 65% methane with the remainder CO2 and other gases, such as nitrogen, hydrogen sulphides and siloxanes. It is currently mainly used to produce electricity in Combined Heat and Power (CHP) engines with heat as a by-product which can be used to heat the digester. It can also be used locally for heating. To be injected into the gas grid or used as a transport fuel the raw biogas must be processed, cleaned of some of the toxic or harmful components and upgraded to biomethane (with a methane content of 96% or above). Only 0.005% of the supply went to use as a transport fuel in 2011.  

5.13 One gas supplier has said that upgrading biogas to biomethane tends to only be economically viable for larger plants with a capacity of over 500 KWh, while liquefaction of biomethane is only deemed effective for even larger quantities of above 4MW. However, technology for more efficient upgrading and liquefication for smaller capacity biogas production is

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32 Add reference
being developed, which may bring a greater proportion of biogas into scope for use as a transport fuel and specifically as liquefied biomethane. For example, under WRAP’s ‘Driving Innovation in AD’ scheme, Evergreen Gas are currently developing a small scale biogas upgrading facility on a farm in Shropshire.

5.14 There are currently three AD sites in the country which upgrade biomethane and inject it into the gas grid, with several more in the pipeline.

Estimates of future biomethane supply

5.15 Developing scenarios on the potential availability of future biomass resources is a challenging task and work is ongoing to improve the evidence base. The Government has committed to promote an increase in the generation of energy from waste through anaerobic digestion. Defra and DECC developed with stakeholders a Strategy and Action Plan – published in 2011 - to tackle the barriers to AD uptake. Almost all the actions have now been delivered. However, there is a finite amount of available waste feedstock for AD and Government is not looking to increase AD from crops. The Government’s Anaerobic Digestion Strategy estimated production of between 3 and 5 TWh of electricity from AD by 2020 (equivalent to less than 1% of the total UK gas demand in 2012) based on realistic assessments of the amounts of feedstock that may be available.

5.16 Some organisations consider this estimate to be on the conservative side. The ADBA has estimated that if all available feedstock were treated through anaerobic digestion then up to 33.8 TWh of energy would be available by 2020. This figure includes landfill gas (which is not included in the Governments AD Strategy estimates) and also includes a significant contribution from food waste. ADBA notes that a lack of separate food waste collection prevents the use of this feedstock with only 7% of UK household food waste being sent to AD in 2011.

5.17 33.8TWh of energy would be equivalent to 2.3mt per year of liquid biomethane which could be sufficient to fuel over 90,000 dual fuel HGVs. This would be more than enough to supply HGVs in line with the medium take-up scenario but substantially more biomethane would be necessary to fuel all HGVs over 18t.

Availability of biomethane as a transport fuel

5.18 Biogas generated from AD is generally used either locally for heat and power or upgraded to biomethane and injected into the national gas grid. Given the limited supply of biomethane, it could be argued that it should be used where it has the greatest impact on decarbonising economic activity. There are relatively few other viable options for decarbonising the transport sector, especially the heaviest trucks on the long-haul duty

cycle. Upgrading biogas to biomethane for use in HGVs has been recognised by the Carbon Trust as the best future use of biogas for reducing emissions\textsuperscript{34}. This is because for the generation of electricity - where a large share of biogas is currently used - there are many other viable options for reducing carbon emissions.

5.19 Lots of factors will influence potential biomethane producers' decisions on where to supply biomethane but many industry members have raised concerns about the current range of incentives in place which may have the effect of diverting biomethane away from use as a transport fuel.

5.20 There are several incentive regimes for the use of renewable energy in different sectors. These have been designed in different ways with the effect that for producers of biomethane greater financial benefits can generally be gained from uses such as electricity generation or heating rather than for transport fuel. Some fuel suppliers and logistics firms have argued that this makes it difficult to source biomethane for use in transport, as they are effectively outbid for this limited resource by electricity and heat suppliers.

5.21 Biogas generated from AD is generally used either locally for heat and power or in a limited number of places is upgraded to biomethane and injected into the national gas grid. Currently biogas is sourced primarily from waste.

5.22 A core principle of the Government's strategy is that support for bioenergy should make a cost effective contribution to UK carbon emission objectives in the context of overall energy goals. In the short term bioenergy plays an important role in all sectors. In the longer term use depends on the availability of carbon capture and storage and other technologies. In some scenarios it plays an important role in decarbonising the heaviest trucks on the long-haul duty cycle, shipping and aviation and high intensity process heating. The Carbon Trust developed a model that allows comparison of the carbon savings and economics of different energy uses of biogas from AD. It found that based on the assumptions used in the model, biomethane as a transport fuel had higher carbon savings potential compared to use for heat and electricity\textsuperscript{35}.

5.23 Lots of factors will influence potential biomethane producers' decisions on where to supply biomethane. Some industry members have raised concerns about the current range of incentives in place which may have the effect of incentivising use of biogas in other sectors over transport. There are several incentive regimes for the use of renewable energy in different sectors. These have been designed in different ways with the effect that for producers of biogas greater financial benefits can generally be gained from uses such as electricity generation or heating rather than for transport fuel (see table 5.1 below). Some fuel suppliers and logistics firms have argued that this makes it difficult to source biomethane for use in transport, as they are effectively outbid for this limited resource by electricity and heat suppliers.

\textsuperscript{34} Carbon Trust, Biogas from Anaerobic Digestion, 2010

\textsuperscript{35} The Carbon Trust: Biogas from anaerobic digestion
Renewable Transport Fuel Obligation

5.24 This scheme is designed to achieve a greater share of renewable fuels in transport and has been in place since 2008. It requires transport fuel suppliers to show that their fuel sales include a specific proportion of renewable fuels. This proportion has been gradually increased since the inception of the RTFO and currently requires a share of around 5% (4.75%) for the year 2013/14.

5.25 While the scheme was designed initially to stimulate the use of liquid biofuels, such as bioethanol and biodiesel, biomethane is eligible for credits under the scheme and the sale of biomethane can be used to meet the obligation. However currently biomethane represents only 1% of the renewable transport fuel under the scheme.

5.26 Certificates are awarded for each kg of biomethane supplied and can be redeemed to meet the obligation of a 5% share for a fuel supplier. For fuel suppliers who sell more than 5% share of biomethane, any certificates above the obligation can be sold on the open market to other fuel suppliers to meet their own obligation, or pay a buy-out price, which stands at £0.30 per litre/kilogram of obligation.

5.27 The RTFO was amended in 2011 and waste-derived fuels, including biogas derived from waste, receive double rewards under the RTFO. The European Commission is currently considering reviewing the Renewable Energy Directive and considering whether to count sustainable biofuels, such as biomethane derived from waste, more highly - potentially double or quadruple count - towards the 10% target for renewable transport energy.

5.28 Industry has also suggested that the RTFO should take account of the energy content of fuels. RTFCs are given to biodiesel per litre and to biomethane per kg, however there is greater energy value in a kg of gas than a litre of diesel. If certificates were awarded on the basis of energy equivalence biomethane would receive 1.9 certificates for each one that it receives today.

Other incentives

5.29 Whilst the RTFO is aimed at increasing the use of renewable fuels in transport, there are a number of other Government incentives to increase and accelerate the use of renewable energy in other sectors.

5.30 The Renewable Heat Incentive (RHI) incentivises a range of different renewable heat technologies such as solar thermal, ground heat pumps and biomass boilers, as well as the production and injection of biomethane into the mains gas grid, and heat and power generated from biogas. Under the scheme, payments are made per kWh of biomethane injected into the grid to the producers of biomethane, as part of long term contract spanning 20 years. The aim is to increase the uptake of these technologies and compensate for the significant capital and operating costs involved in installing and running these heat technologies.
5.31 The Renewables Obligation (RO) provides incentives for large-scale renewable electricity generation by making UK suppliers source a proportion of their electricity from eligible renewable sources.

5.32 The Feed-in Tariffs (FITs) scheme pays energy users who invest in small-scale, low-carbon electricity generation systems for the electricity they generate and use, and for unused electricity they export back to the grid.

5.33 These support mechanisms have been designed in different ways. Table 5.1 below shows the range of support available for biomethane under these schemes.

<table>
<thead>
<tr>
<th></th>
<th>Heat</th>
<th>Transport</th>
<th>Electricity</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Renewable Heat Incentive</td>
<td>Renewable Transport Fuel Obligation</td>
<td>Feed-in Tariffs</td>
</tr>
<tr>
<td>£/MWh (biomethane)</td>
<td>£73</td>
<td>£7.37-£26.47</td>
<td>£32.37-£53.06 (anaerobic digestion)</td>
</tr>
</tbody>
</table>

Notes: The RHI support for biomethane is based on the energy content of the renewable biomethane injected into the gas grid. In addition to this, the RHI provides support for installations generating heat from biogas, which includes gas from anaerobic digestion and syngas from gasification or pyrolysis. Installations with a thermal capacity of 200kW or less receive a tariff of 7.3p/kWh (£73/MWh) and in September 2012 DECC consulted on introducing support for heat from biogas with thermal capacities above 200kW.

The RO and FIT schemes for electricity is based on electricity generated, not biomethane energy input. So an assumed efficiency of conversion is required to convert the support available to input (biomethane) energy to allow comparisons with the other data in the table. In this calculation we have assumed 35% biomethane energy to electricity efficiency.

The RO support depends on the source of the biomethane. Renewable Obligation support for landfill (LF) gas in 2013/14 is 0 ROCs for open sites, and 0.2 ROCs for closed sites. RO data for landfill gas does not take account of Waste Heat to Power generation support. RO support for Anaerobic Digestion (AD) is 2 ROCs in 2013/14. See ‘Government Response to the consultation on the proposals for the levels of banded support under the Renewables Obligation for the period 2013-17 and the Renewables Obligation Order 2012’ for further detail.

RTFO support estimates are based upon biomethane receiving double certificates, and have been assessed across a range of observed RTFC prices which have been published over the period December 2011 to July 2013 (http://www.nfpa-auctions.co.uk/etoc/trackrecord.html). Level of support is shown in 2013/14 prices.

5.34 Biomethane produced from landfill gas does not qualify for either the RHI or the Feed in Tariff. It is eligible for support through the Renewable
Obligations scheme but as an established source of biomethane, it is only eligible for the lower level of support\(^\text{36}\). Operators have found that the only source of biomethane currently available for direct use in transport comes from landfill gas and demand currently exceeds supply.

**Biomethane supplied through the national transmission system**

5.35 Whilst renewable energy incentives may be an issue where biomethane is supplied directly from the processing plant, biomethane injected into the national transmission system benefits from support under the RHI which is paid to the producer of the biomethane. It is widely expected that a number of new biomethane plants will begin injecting into the grid in the years to come, and this resource will be available to any user, including HGV operators. However, using gas from the grid has the following limitations:

- Use is restricted to locations where there is access to the grid at the appropriate pressure
- Only CNG is available unless the gas is liquefied which would have implications for the overall GHG emissions
- There is currently no recognition of biomethane use for operators

**Biomethane certification scheme**

5.36 Some operators would be prepared to pay extra for biomethane (and record the emissions benefit) but it becomes mixed with natural gas once it enters the national transmissions system. Certification schemes have been set up overseas and more recently in the UK to track the biomethane and ensure that only one user is able to claim the carbon emissions benefit. Currently in the UK, carbon reporting guidelines stipulate the operators must use the CNG conversion factor if biomethane is purchased in this way. Operators would like to be able to apply the biomethane conversion factor to reflect the purchase of this alternative fuel Defra’s Environmental Reporting Guidelines published in June 2013 noted that the accounting of grid-injection biomethane was under review. On 24 February 2014 Defra announced its proposal to enable companies to reflect purchases of biogas and biomethane, if they hold corresponding documents certifying that the gas has been injected into the gas grid. A short consultation has been launched on how this should be presented in company reports\(^\text{37}\).

5.37 Currently two schemes have been set up in the UK for the certification of biomethane. The Biomethane Certification Scheme, developed by Green Gas Trading Limited certifies biomethane, whether injected into the gas grid or liquefied or compressed for use as a transport fuel, and provides a platform intended to facilitate the trading of certificates to maximise the

\(^{36}\) https://www.gov.uk/calculating-renewable-obligation-certificates-rocs

\(^{37}\) https://consult.defra.gov.uk/climate-change/ac04ad33
value of biomethane, at a market determined price. The Green Gas Certification Scheme, run by Renewable Energy Assurance Limited, certifies biomethane injected into the gas grid only, but tracks the flow of the gas from supplier to final point of use. Such schemes may help to incentivise biogas producers to make a greater volume of the gas available as biomethane for vehicles rather than using it for electricity or heating.

Standards and specification of biomethane and natural gas as truck fuels

5.38 Raw biogas needs to be upgraded to biomethane to be used as a vehicle fuel (and to be injected into the gas grid). There are different processes for this and depending on whether the biomethane it to be used as compressed or liquefied gas some processes may offer a more efficient pathway than others: membrane separation technology requires the gas to be pressurised and produces compressed biomethane. If this is fed into a gas grid with a similar pressure level energy can be saved. For grid injection, sometimes propane needs to be added to the methane to increase its calorific value. Cryogenic separation is an efficient upgrading process if the gas is to be used as Liquefied biomethane. During this process carbon dioxide and other trace gases can be removed as part of the liquefaction process.

5.39 Some upgrading technologies are associated with more residual methane remaining in the 'lean gas stream' which needs to be treated to avoid it emitting into the atmosphere. Standards for the emissions of methane from upgrading facilities should be set in order to ensure that the benefits of biomethane are not undermined. In Germany, a maximum methane content in an upgrading plant’s lean gas stream is set in regulations and needs to be met to qualify for government subsidies. The Anaerobic Digestion and Biogas Association would support similar efficiency standards for upgrading facilities.

5.40 Following on from a recent public consultation on a draft protocol, it is expected that an Environment Agency (EA) quality protocol for biomethane will be in place by autumn. This aims to set out the required standards for biomethane so that is no longer classified as waste and subject to waste management regulations. This includes a quality specification with maximum limits for the compounds that biomethane for use as vehicle fuel or for injection into the gas grid may contain, and a regime for monitoring that biomethane produced for the specified purpose complies with the specification. The quality protocol will require biomethane producers to supply a statement and analytical test results to show that their product has been produced in accordance with the requirements of the Quality Protocol.

5.41 In the absence of a common UK or EU quality standard, up to now suppliers have often adhered to a Swedish standard for biomethane used as a transport fuel. Alongside the quality protocol, the European Committee for Standardisation is in the process of developing a common
European standard for biomethane as a vehicle fuel and for grid injection, standard CEN/TC 408.38

5.42 An international ISO standard for natural gas is also under development, aimed at standardizing quality specifications and other aspects of natural gas and natural gas substitutes in all their forms from production to delivery to all possible end users.39 This would address the issue of some grid gas (sourced from Zeebrugge) having too high an ethane content which makes it unsuitable as a vehicle fuel without prior processing, as it can damage the engine.

5.43 In the UK in order to be injected into the gas grid biomethane needs to be comply with the specifications set out in the Gas Safety (Management) Regulations Schedule 3 (“GSMR3”), which include requirements for the composition of gas. There are strict gas specifications for the GB network. Any new fuel specification would need to be aligned to the current gas specification used in the network – or adapted at exit points. Currently gas quality standard regulations for the network are overseen by OFGEM and the Health and Safety Executive.

5.44 The quality protocol and EU and ISO standards should ensure common quality standards and reliability of biomethane and fossil natural gas purchased in the EU and remove any concerns about issue like combustion knock, which can lead to engine damage and failure and can occur if certain compounds are present in the methane.

5.45 It has been suggested that the sulphur-based stenching agent used in the national grid may affect methane catalysts in gas vehicles. However to date dual fuel technology suppliers have not encountered any issues and it is thought that the sulphur content is too low to cause any problems, indeed the methane catalysts are designed to be robust against the low sulphur content of diesel fuel.

38 www.cen.eu
39 www.iso.org/iso/home/store/catalogue_tc/catalogue_tc_browse.htm?commid=54448&development=on
6. Overview of the costs and benefits of using methane

The drivers for fleet operators

6.1 Fleet operators tend to introduce gas fuelled trucks into their fleets for two reasons: to reduce their GHG emissions or wider environmental impact and to reduce costs associated with fuelling their fleet. The former is an important driver for some companies who may have set explicit targets for reducing the carbon intensity of their operations, and where this plays an important part in their company’s public profile, their corporate social responsibility (CSR) commitments. It can also further their commercial interests as clients and customers may consider the carbon profile in their business decisions.

6.2 A case study from Howard Tenens illustrates an operator’s reasons for investing in gas HGVs (Chapter 7).

Carbon reporting

6.3 For the reporting year ending in September 2013 new regulations for mandatory carbon emissions reporting apply for UK-registered, stock market-listed companies. Emissions from the combustion of fuels in transportation devices such as trucks must be included in the annual quantity of GHG emissions reported. While reporting of carbon emissions is not mandatory for companies that aren’t listed, it is encouraged and many companies do choose to include this information.

Energy audits

6.4 On 10 July 2013 the Department of Energy and Climate Change published a consultation on its proposed Energy Savings Opportunity Scheme which would implement Article 8 of the European Union Energy Efficient Directive (energy audits). The Directive requires Member States to introduce a programme of regular energy audits for large undertakings to review the total energy use and energy efficiency of the organisation, including key transport activities. The consultation closed in October, DECC are currently analysing the results and intend to publish its Government response and bring forward legislation ahead

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41 Individual UK organisations are considered large if they:
• Have 250 or more staff (e.g. partners, owner/managers and employees) in the UK, or;
• Have a turnover exceeding Euro 50m and total assets exceeding Euro 43m in the UK; and/or
• Are, at the qualification date, part of a corporate group that includes one or more organisations that meet either of the above qualification criteria

42
of the transition deadline of 5th June. Large undertakings will need to comply with the requirements by December 2015.

**Fuel costs**

6.5 For many companies reducing fuel costs is just as, or more, important than environmental considerations and it would not be commercially viable to use an alternative fuel or carbon reduction technology if it increased overall costs. For smaller operators who operate on very tight margins opportunities to make significant fuel savings will be extremely important but will only be viable with short payback periods and minimal upfront investment.

**Costs for operators**

6.6 Costs for operators are related to technology and infrastructure, plus maintenance. The exact balance of costs and benefits and payback period of additional investment will vary in each case. The LowCVP’s cost modelling report shows a range of cost savings of between £7,000 and £51,000 for a dual fuel truck compared to an equivalent diesel HGV (at 2010 prices) with associated break even points for the additional capital costs after between 2.8 to 6.6 years but industry members consider that the payback period is longer than this for the heaviest vehicles.

**Vehicles/technology**

6.7 As set out in Chapter 4 above, the cost differential between a new or retrofitted gas truck and a standard diesel truck ranges from £15,000 to £44,000.

**Maintenance costs**

6.8 Gas vehicles currently attract higher maintenance costs averaging £2,000 per year. Additional costs have also been reported for replacement fuel injectors after 5 years at a cost of £2,000. These additional costs can be recouped over a number of years due to the lower costs of gas fuel compared to diesel.

6.9 In the absence of a second hand gas HGV market there is little data about the costs associated with running a gas truck for second or third users. Competitively priced used gas trucks, in combination with access to public or shared refuelling facilities should allow operators running fleets of used truck to access the fuel savings associated with gas trucks within viable payback periods, as they are unlikely to be able to afford significant upfront capital costs unless payback occurs quickly.
Refuelling infrastructure

6.10 Many operators will prefer to install their own on-site refuelling stations, as is currently the case with many diesel-based fleets. Operators will therefore incur costs to install, operate and maintain refuelling facilities, as well as the cost of purchasing any additional land required (see Chapter 4).

6.11 The Government provides Enhanced Capital Allowances for expenditure on new plant and machinery installed at gas refuelling stations (natural gas and biogas). This means that the cost can be off-set against the operator's taxable profits in the financial year the purchase was made. This allowance is available until 31 March 2015.42

Benefits

Reductions in fuel costs

6.12 The main financial benefit accrues to fleet operators as natural gas is cheaper than diesel. The price of gas ranges from £0.80 - £1.05 per kg with CNG being at the lower end and liquefied biomethane at the upper end, compared to around £1.39 per litre of diesel (pump price, inclusive of VAT which is recoverable). Where operators use on-base or shared access private refuelling stations, unit costs will be dependent on capacity and the type of supply contract, as is the case with on-site diesel stations.

Box 6.1 Fuel duty differential

A substantial proportion of the fuel cost savings associated with using methane result from the fuel duty rate which at 0.2470 per kg is significantly lower than the duty rate of 0.5795 per litre of diesel. Taking into account energy content43, the duty levied on gas is around 70% lower than that for diesel.

Until recently, the duty differential has been guaranteed on a rolling 3 year basis. Operators considered that this did not provide sufficient long-term certainty about the recovery of additional investment costs in gas trucks through fuel cost savings to incentivise significant uptake of gas powered vehicles and indicated that providing a longer guarantee would improve the investment environment to encourage them to switch from diesel to gas.

42 http://www.hmrc.gov.uk/manuals/camanual/CA23155.htm
43 In terms of energy content 1 kg of natural gas is equivalent to 1.462 litres of diesel.
Autumn Statement 2013
The fuel duty differential for road fuel gases was extended to 2024 in the Autumn Statement. A longer-term guarantee on the duty differential between diesel and gas fuel may enable fleet operators to compile business cases with viable payback periods on investment with greater confidence, reducing the risk associated with investment in gas trucks and refuelling facilities. A longer term guarantee may also lead to better resale values, which should in turn encourage the development of wet leasing products which would help grow the market.

Biomethane
Some industry representatives believe that there is a case for zero-rating fuel duty on biomethane in line with zero-rates for other low carbon fuels, given its substantial carbon savings.

6.13 The Freight Transport Association has provided anonymised examples of fuel costs and savings per vehicle from some of its members, these are set out in table 6.1 below. The initial upfront costs of the vehicle conversion and supporting infrastructure have not been included in these examples.
These examples reflect a range of different factors including fuel type, distance travelled and technology type.

The economic benefits of methane can be adversely affected by changes in crude oil/diesel prices. One operator reported that reductions in diesel prices in 2012 increased the payback period for the lifetime costs of a dual fuel LNG versus standard tractor from 22 months to 37 months.

Wider benefits

As well as the benefits noted elsewhere in this document including reduced carbon emissions, air quality improvements and reduced vehicle noise there are other potential benefits to the UK such as reducing reliance on imported oil and creating jobs.
Reduction in oil/diesel imports

6.17 Displacing oil imports with less expensive methane would be expected to boost GDP through the balance of payments channel (as less money would be leaving the country due to a lower fuel import bill).

6.18 While an increasing share of natural gas demand in the UK is met from imports, there is still a significant domestic supply, and a possibility of greater domestic supply becoming available through shale gas extraction. Increasing quantities of crude oil and diesel are also imported. Wholesale gas is significantly cheaper than diesel and the gap is projected to increase.

6.19 An expansion of domestic biomethane production will provide a source of indigenous gas supply that will contribute to greater energy security and insulation from oil price increases. Increased demand for biomethane from the HGV sector could encourage greater production. Lower energy costs and less dependence on imports will contribute to boosting growth.

Job creation and economic growth

6.20 The UK is well-placed to benefit from the development and production of gas vehicle and refuelling technology as well as supply of gas fuels, as several major companies are based in the UK. In addition, the reduction of costs for the freight industry through access to cheaper fuel will improve the competitiveness of this sector of the UK economy. The FTA is a key funder and supporter of the campaign by FairFuelUK for fuel duties to be reduced. As part of that campaign, two studies were commissioned during 2012 - the first by CEBR (Centre for Economics and Business Research) and the second by NIESR (the National Institute for Economic and Social Research) - looking at the economic impacts of a freeze in fuel duties and then of a cut in duties. Both pieces of work demonstrate that a change of approach could deliver significant benefits including creating jobs, boosting GDP and, in some circumstances, delivering a net increase in tax revenues. The modelling shows the benefits to be optimised at a reduction of 3ppl and that, taken together, these increases in disposable income for consumers and an improvement in free cash for businesses would be spent or invested elsewhere in the economy, leading to the stimulus in activity and partial recovery of foregone revenue through other taxation."

6.21 Greater use of biomethane rather than natural gas will increase the benefits related to reducing reliance on oil imports and the creation of jobs and economic growth.
Synergies with wider government policy objectives

6.22 In addition to these specific benefits, there are also synergies between expansion of gas HGV and a number of public policy objectives and regulative requirements.

6.23 The Anaerobic Digestion Strategy and Action Plan\(^\text{44}\), issued by DECC and Defra in 2011, stated that the Government and its partners were committed to facilitating biomethane injection into the national grid, and the use of biomethane as a transport fuel.

6.24 In addition, the UK is required, under the European Union's (EU's) 2009 Renewable Energy Directive to meet 15% of its energy consumption from renewables by 2020, and specifically to source 10% of energy used for transport from renewable sources. The use of biomethane as an HGV fuel presents an efficient and viable option to help meet this target.

6.26 The UK Bioenergy Strategy\(^\text{45}\) sets out the Coalition Government’s approach to achieving sustainable, low-carbon bioenergy deployment by defining a framework of principles that will govern future policies, including the role of biomass in transport.

6.27 The UK government is committed to meeting EU air quality standards and this work will help us work towards compliance.


7. Case Study: Howard Tenens

Howard Tenens are one of the largest privately owned logistics companies in the UK and has steadily introduced dual fuel vehicles into the fleet since 2009 as part of its strategy to cut carbon emissions.

At the end of 2013 the dual fuel fleet expanded considerably to 57 vehicles assisted by grant funding from the Office of Low Emission Vehicles (OLEV) and Technology Strategy Board (TSB). This means that 88% of its fleet over 18 Tonnes are dual fuel, making it one of the largest dual fuel fleets in the UK. It operates a mix of DAF and Mercedes vehicles.

The environmental benefits of operating dual fuel vehicles are considerable. A dual fuel vehicle operating on CNG saves up to 15% CO2 compared to an equivalent diesel vehicle, and up to 60% if operating on biomethane. Introducing dual fuel vehicles into the fleet has been instrumental in driving down the company’s carbon footprint. In 2011-12 the company saved just under 1,000 tonnes of CO2 due to its dual fuel fleet, equivalent to an 8% reduction in overall fleet emissions.

The company began trials of CNG in 2009 and since then has worked closely with various conversion companies to develop the best methods for incorporating gas tanks to its vehicles. The original trial vehicles had gas containers on both the tractor unit and the trailer. This created some operational constraints, and later vehicles were designed so that all gas could be stored on the tractor unit, giving ranges of between 750 and 900 km on dual fuel operation. In some cases this has meant moving AdBlue and fuel tanks and repositioning the exhaust.

Howard Tenens has also installed refuelling stations at three depots - Boston (Lincs), Aveley (Essex) and Andover, (Hampshire). A new gas station is also being built in Swindon and is due to be operational in February 2014. All stations are open to third parties with prior agreement.

All sites have grid connected CNG stations apart from Andover which is an LCNG biomethane station which dispenses the fuel as a compressed gas. Howard Tenens aims to maximise its use of biomethane in the future as it is a much more sustainable fuel and can deliver greater carbon savings. Although current availability of biomethane is limited, there are many anaerobic digestion plants due to come on line soon and this will lead to increased availability of the fuel via the national gas grid in the near future.
Catherine Crouch, Howard Tenens’ group corporate responsibility and sustainability director said:

“Dual fuel vehicles have proved to be a viable alternative to diesel and are now firmly integrated into our fleet. Operating a dual fuel fleet differentiates us in the marketplace and reduces both our carbon footprint and that of our customers’ supply chain.”
Appendix 1 - Natural gas and biomethane pathways

The Low Carbon Vehicle Partnership has produced the following diagrams to illustrate the pathways for producing and supplying natural gas and biomethane for use as a road transport fuel.

Figure 1 - Natural Gas Pathways - CNG

European origin natural gas source: Norway/Zeebrugge
NTS – low pressure gas transmission system
LTS – high pressure gas transmission system
Liquefaction takes places at Avonmouth LNG storage terminal
Figure 2: Natural Gas Pathways - LNG

Figure 3 Biomethane Pathways CNG & LNG

Note: LNG pathway related to Bio-LNG: See Figure 2 - NG liquefaction at Avonmouth road tankering to landfill site (Surrey) plus LNG road tankering from Europe (Zeebrugge).
Appendix 2: Task Force members and participants

Core Task Force members:

Freight Transport Association
Road Haulage Association,
Chartered Institute of Logistics and Transport,
The Society of Motor Manufacturers and Traders,
Low Carbon Vehicle Partnership
Transport Knowledge Transfer Network

The Task Force is supported by:

The Department for Transport
The Office of Low Emission Vehicles
The Department Environment, Food and Rural Affairs

Wider Task Force participants:

Anaerobic Digestion and Biogas Association
DAF Trucks
Department for Energy and Climate Change
Gasrec
John Lewis Partnership
Mercedes-Benz
The Stobart Group
Tesco
UPS
Veolia
Wincanton