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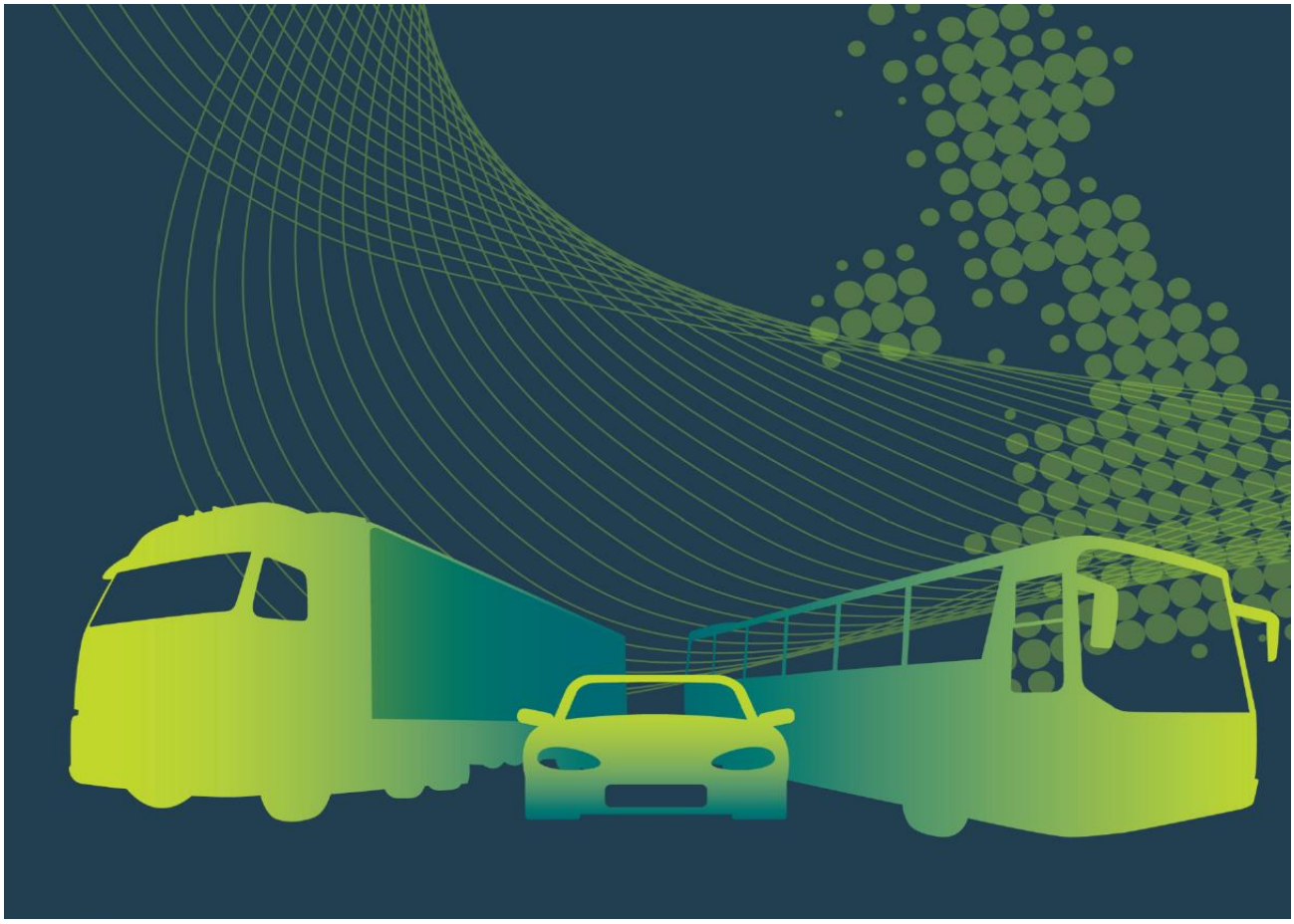
Low Carbon Truck and Refuelling Infrastructure Demonstration Trial Evaluation

Second Annual Report to the DfT

Executive Summary for publication

July 2015



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Rev 1.1	Second annual report to the DfT – Executive Summary draft	SK	SC	SK	HV	19/05/2015

Executive Summary

The Department for Transport (DfT), the Office for Low Emission Vehicles (OLEV) and Innovate UK (formerly the Technology Strategy Board, TSB), are co-funding the Low Carbon Truck and Refuelling Infrastructure Demonstration Trials (Low Carbon Truck Trial): £11.3m provided by Government to pump prime procurement of low emission HGV technologies and their supporting infrastructure and leveraging over £12m of industry investment to create a £23.4m trial.

The funding was made available through a competition run by the then TSB in 2012 with the funding paid to individual consortia members as grant. Following the competition, 13 projects were provisionally accepted for funding including a majority of dual fuel vehicles, some dedicated gas vehicles and some vehicles running on used cooking oil. Projects also included proposals for refuelling stations. Although the competition was technology neutral and therefore open to electric and hybrid vehicles, no applications for funding for such vehicles were received.

The trial aims to enable commercial vehicle operators to learn about alternative fuel vehicles and enable low-carbon vehicle producers to learn new ways to develop their products. The trial is also initiating publically-accessible gas refuelling infrastructure and generating a body of data to inform Government policy and industry investments through better information on potential emission reductions, fuel savings and operational benefits.

The DfT commissioned Atkins and Cenex to undertake a research project for data collection and analysis to demonstrate the impacts and benefits of using low carbon trucks across a range of freight operations. Specific objectives for the research project are: *"to gather and analyse data from the Low Carbon Truck and Refuelling Infrastructure Demonstration Trials on the emissions and other benefits, including fuel cost savings, from the different vehicles and different technologies in different operations; as well as the costs of running the vehicles and their associated infrastructure."*

Consortia progress over the first two years of the trial

Consortia agreements

By December 2013, all 13 consortia had signed their agreements for the trial. In December 2014, **11 consortia were progressing** with their project. At the end of 2014 new partner Culina Logistics joined the CNG Services Magna Park consortium and Gasrec Ltd joined the GoByGas consortium; all the other consortia members have remained the same from the end of December 2013. The LCV Amber project was closed following T. Baden Hardstaff Limited and Hardstaff Commercial Repairs Limited entering administration on 6th February 2015

Consortium members, their role, refuelling infrastructure and trucks on the road and planned are detailed below in Executive Summary Table 1.1. Appendix A includes a selection of photos that illustrate the types of technologies being used in the trial.

Abbreviations used in this report are as follows:

CNG – Compressed Natural Gas

LNG – Liquefied Natural Gas

UCO – Used Cooking Oil

Executive Summary Table 1.1: Low Carbon Truck Trial Summary

Consortium Name	Partners	Partners Role	Fuel	Refuelling Sites Deployed	Size of Trucks	Propulsion Technology	Trucks on Road (end of 2014) / Planned
Wisely Driven Fuel Partnership	Muller- Wiseman	Lead Partner/ Operator	LNG	Droitwich Spa Bellshill	40 tonnes	LNG Dual Fuel - Volvo Original Equipment Manufacture (OEM)	39 on road 0 planned 1 truck written off
	Chive Fuels	Refuelling					
	Cenex	Study partner					
	Mira	Emission Testing					
GoByGas	Biomethane Ltd	Lead Partner/ Refuelling	L/CNG	Location TBC	26 tonnes 44 tonnes		27 on road 0 planned 1 truck written off and replaced 10 vehicles purchased outside trial
	Gasrec Ltd	Refuelling	L/CNG				
	Wincanton Plc	Operator	LNG			15 LNG Dual Fuel – Mercedes Hardstaff Conversion	
	Howard Tenens	Operator	CNG			12 CNG Dual Fuel - 10 DAF and 2 Mercedes Prins Conversions	
Dual Fuel Pathfinder	Stobart	Lead Partner/ Operator	LNG	Warrington	44 tonnes	LNG Dual Fuel - Volvo OEM	20 on road 0 planned
	BOC Group	Refuelling					
Environmental Efficiency	Brit European Transport	Lead Partner/ Operator	CNG	Scunthorpe (planned)	44 tonnes	30 CNG Dual Fuel - Mercedes Hardstaff Conversion 6 CNG Dual Fuel - MAN Prins Conversion	36 on road 0 planned
	CNG Services	Refuelling					
	Microlise Ltd	Telemetry					
Tesco Engineering/ The Hardstaff Group Dual Fuel Operational Fleet Trial	Tesco Engineering	Lead Partner/ Operator	LNG	None	44 tonnes	LNG Dual Fuel – Mercedes Benz Hardstaff Conversion	35 on road 0 planned
	Hardstaff Group	Manufacturer					
Environmental and Performance	United Biscuits	Lead Partner/ Operator	UCO	Ashby-de-la-Zouch	44 tonnes		

Executive Summary Table 1.1: Low Carbon Truck Trial Summary

Consortium Name	Partners	Partners Role	Fuel	Refuelling Sites Deployed	Size of Trucks	Propulsion Technology	Trucks on Road (end of 2014) / Planned
Impact of Direct Use of Used Cooking Oil in 44-tonne trucks under real world driving conditions	Biomotive Fuels Ltd	Fuel				10 UCO Dual Fuel – Mercedes Benz Bioltec Conversion	10 on road Euro VI truck converted outside of trial
	Leeds University	Emission Testing					
Collaborative Ultra Low Carbon Demonstrator Vehicles	John Lewis Partnership	Lead Partner/ Operator	CNG	None in Trial Using existing facilities	28 tonnes 31 tonnes 40 tonnes 44 tonnes Trailers	6 CNG Dual Fuel – DAF Prins Conversion 6 Trailers	18 on road 1 Euro VI Truck to be added in March 2015 by Howard Tenens
	Howard Tenens	Operator				2 CNG Dual Fuel – Mercedes Benz Prins Conversion 4 CNG Dual Fuel – DAF Prins Conversion 6 Trailers	
	Lenham Storage	Operator - Trailers				6 CNG Dual Fuel – DAF Prins Conversion	
	Cambridge University	Emission Testing					
ENTRIS – Evaluation of Natural Gas refuelling in Swindon	Howard Tenens	Lead Partner/ Operator	CNG	Swindon	31 tonnes 44 tonnes	7 CNG Dual Fuel – DAF Prins Conversion 12 CNG Dual Fuel – Mercedes Benz Prins Conversion	54 on the road 0 planned
	John Lewis Partnership	Operator				32 CNG Dual Fuel – DAF Prins Conversion	
	Lenham Storage	Operator				2 CNG Dual Fuel – DAF Prins Conversion 1 CNG Dual Fuel – Mercedes Benz Prins Conversion	

Executive Summary Table 1.1: Low Carbon Truck Trial Summary

Consortium Name	Partners	Partners Role	Fuel	Refuelling Sites Deployed	Size of Trucks	Propulsion Technology	Trucks on Road (end of 2014) / Planned
	Emissions Analytics	Emissions Testing					
	CMS Supatrack	Telemetry					
Go Truck	Container Ships Ltd	Lead Partner/ Operator	LNG	Teesport (planned)		30 LNG Dual Fuel – MAN G-Volution Conversion	2 on road 28 planned
	G-Volution	Manufacturer					
DAF Truck	G-Volution	Lead Partner/ Manufacturer	LNG	1 planned (location TBC)		10 LNG Dual Fuel – Mercedes G-Volution Conversion	0 on road 10 planned
	Container Ships Ltd	Operator					
CNG Services Magna Park	CNG Services	Lead Partner/ Refuelling	CNG/ LNG	Magna Park	44 tonnes	35 LNG Dual Fuel – Mercedes, and Volvo OEM 26 LNG Dual Fuel - Prins Conversion 5 Scania CNG only – Scania planned	26 vehicles on the road 40 planned
	Argos	Operator					
	DHL	Operator					
	Stobart	Operator					
	Culina	Operator					
CNG Services Evergreen	CNG Services	Lead Partner/ Refuelling	LNG	Droitwich Purfleet Bristol (Upgrade) Flamstead (Upgrade) Wolverhampton (Upgrade) Lymm (upgrade) Castleford (upgrade) Tebay services (upgrade) 3 planned (location TBC)	44 tonnes	1 LNG Dual Fuel – Volvo OEM 20 LNG Dual Fuel – Volvo 11 LNG Dual Fuel – Mercedes Prins Conversion	32 on the road 0 planned
	Chive Fuels	Refuelling					
	Gasrec	Refuelling					
	DHL	Operator					
	KBC	Operator					

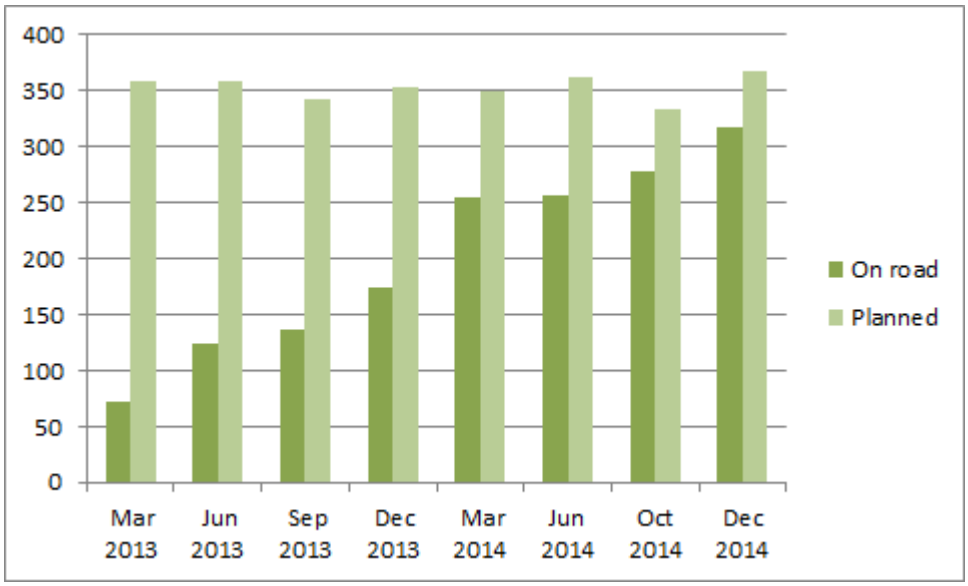
Trial vehicles

By the end of 2014, 317 trucks were on the road (91 additional dual fuel LNG vehicles and 51 additional CNG vehicles when compared to the end of 2013). This represents 86.4% of the vehicles planned (in Dec 2014/Jan 2015). All 18 low carbon aerodynamic trailers were in use in the John Lewis Partnership led consortium.

When considering the **type of technologies** used or proposed by trial participants, 64 vehicles (17%) will be using gas equipment (59 dual-fuel, 5 gas only) fitted by the vehicle manufacturer from new (i.e. Original Equipment Manufacture (OEM)) and 303 vehicles (83%) will be using a range of dual-fuel conversion technologies available from Hardstaff, Prins, Clean Air Power, G-Volution or Bioltec. The majority of vehicles are using LNG (236 vehicles), with 121 vehicles using CNG and 10 vehicles running with used cooking oil (UCO). The majority (66%) of vehicles are in the 40-44 tonnes gross vehicle weight (GVW).

Figure 1.1 shows increases in the number of trucks on the road for each quarter. The most significant increases have been between March and June 2013, at the start of the trial, and between December 2013 and March 2014 with approximately 80 trucks starting to be used for each of these periods. 142 trucks have joined the trial fleet in 2014.

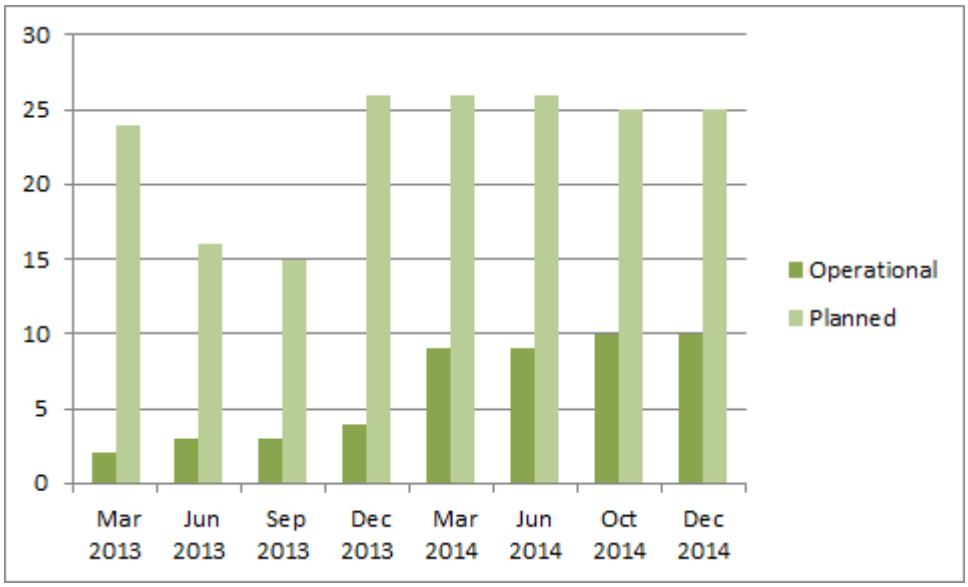
Figure 1.1: Number of trucks planned and on the road



Refuelling infrastructure

16 new stations were initially proposed at the bidding stage. Of these, four were commissioned by the end of 2014. Of the nine planned upgraded stations, six were completed by the end of 2014. **Figure 1.2** below shows progress made throughout the trial on refuelling infrastructure:

Figure 1.2: Number of refuelling stations planned and operational



Stations commissioned or upgraded through the trial by the end of 2014 are:

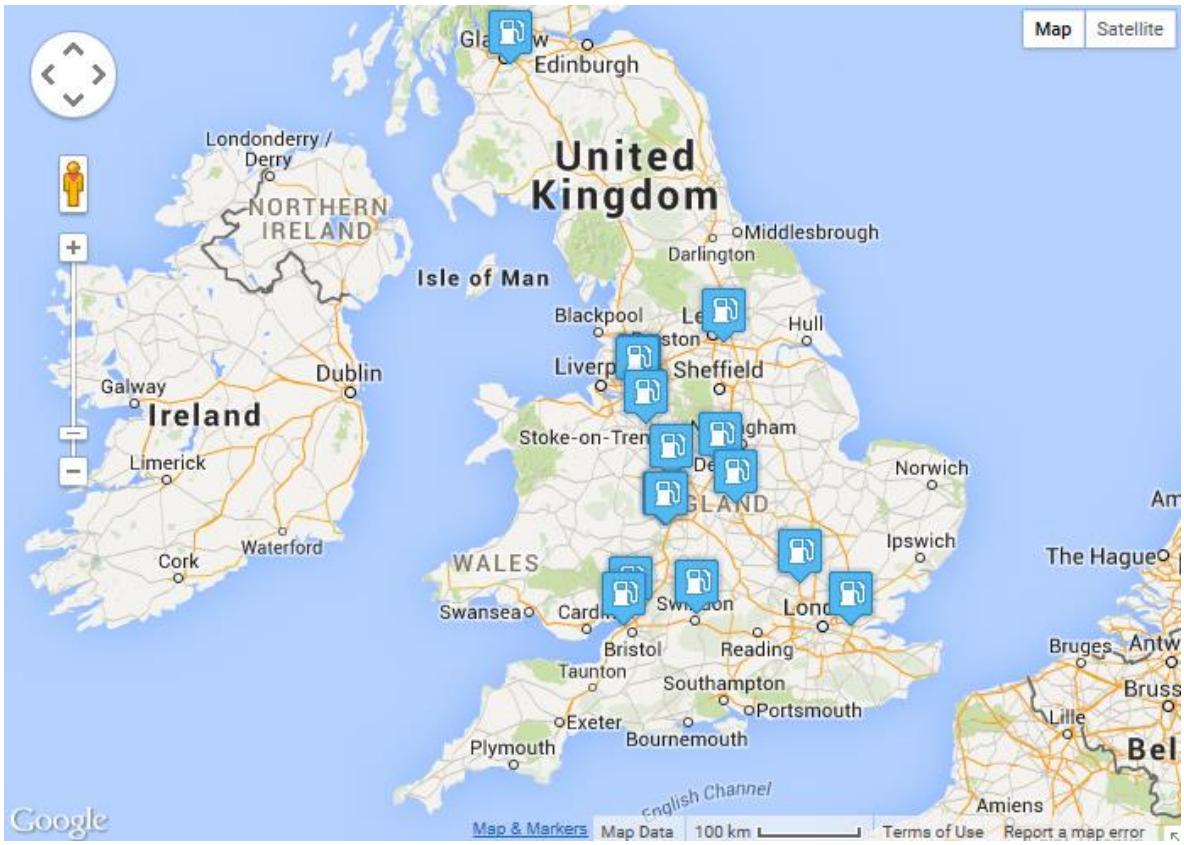
- New
  - One new LNG station at Stobart's site in Appleton Thorne, near Warrington;
  - One new CNG station at Howard Tenens site in Swindon;
  - One new LNG station at DHL's site in Droitwich;
  - One new used cooking oil station at the United Biscuits' site.
- Upgraded
  - Two LNG refuelling stations upgraded at Muller-Wiseman's sites, in Bellshill, Scotland and in Droitwich, Worcestershire;
  - Four upgraded LNG stations: one at KBC's site in Purfleet and three Chive stations in Bristol, Flamstead (Bedfordshire) and Wolverhampton.

Station commissioning is expected to continue during 2015 with 12 new and 3 upgraded stations planned:

- New:
  - Six stations to be commissioned through the GoByGas consortium (with Biomethane Ltd providing one station and Gasrec planning to provide the remaining five stations, locations to be confirmed);
  - The Brit European led consortium is planning to commission a CNG station in Scunthorpe, to operate as a daughter station to the Crewe station, in June 2015;
  - Three new motorway LNG stations are planned through the CNG Services Evergreen project for June 2015, locations to be confirmed;
  - One L/CNG station for Magna Park (CNG Services led consortium) to be commissioned by September 2015;
  - LNG station planned for 2015, location still to be confirmed (DAF Truck project);
  - The Go-Truck consortium has plans to deploy an LNG station at Teesport to be commissioned by September 2015.
- Upgrades:
  - As part of the CNG Services Evergreen project, station upgrades are planned at existing Chive stations in Lymm, Tebay and Castleford for April 2015.

A map detailing live refuelling sites can be found at the Gas Vehicle Hub website (http://gasvehiclehub.org/low-carbon-truck-trial?sid=284:Trial-Funded-Stations). A map of the existing sites is detailed below in **Figure 1.3:**

Figure 1.3: Live Refuelling Sites



Source: Gas Vehicle Hub Website (March 2015)

Monitoring and evaluation data

Data Protocols documents (reporting guidance and spreadsheet templates) were issued to all consortia. Consortia are generally using their vehicle telematics and fuel management systems to provide data and are able to provide, as a minimum, data on mileage per shift/day and fuel transferred per refuelling event. This allows statistics to be produced for mileage covered by the trucks, fuel consumption, gas/used cooking oil substitution rates and CO_2 performance.

Trial data analysis

Additional capital and maintenance costs

Additional **capital costs** to purchase or retrofit a dual fuel vehicle can vary significantly according to technology chosen, vehicle make and model, integration issues and LNG/CNG tank size. The UCO system costs around £6,000 with costs ranging between £11,500 and £33,000 for the gas systems. Average consortium spend is £25,000 on a dual-fuel gas system.

Additional scheduled **maintenance costs** for the dual fuel gas retrofit systems are on average reported to be circa £700 per annum. The dual fuel systems on the trial trucks increased **downtime duration** by 22% when compared to the downtime reported for comparator diesel vehicles. The downtime duration represents the amount of time a truck is out of service due to unscheduled maintenance.

Mileage statistics

Across the 256 vehicles currently reporting (at 31st December 2014) distance data, the trial vehicles are covering over three million km per month (over 12,000 km per vehicle per month). The average daily distance travelled per truck is 576 km.

Fuel Cost

In 2014, the cost of CNG (excluding VAT) from public access third party sites ranged from 75p/kg to £1.05/kg. LNG ranged from 88p/kg to £1.06/kg. The average cost of Bio-CNG was 7p/kg more than fossil CNG. The average cost of bio-LNG was 1p/kg more than fossil LNG.

On average the biomethane blend into natural gas used across the trial vehicles is 7% in LNG and 4% in CNG. This varies from fleets using an average of 0% biomethane blend up to 26% in LNG and 40% in CNG.

Payback analysis

Low carbon truck payback analysis is due to be reported in the final trial report in 2016.

CO_2 emission savings

For the fleets which are currently providing enough data to enable analysis of fuel efficiency and CO_2 emission savings, the following results are emerging:

Dual fuel gas vehicles

- On average, the **dual fuel gas** vehicles (currently 256 vehicles are reporting data) are showing a **substitution ratio[1] of 44%.** This ranges from about 30% to 50% dependent on the dual fuel system being used.
- The systems have an average engine efficiency[2] reduction of 5%.
- Fleets are experiencing Tank to Wheel[3] (TTW) emission savings of up to 12% and Well-to-Wheel[4] (WTW) savings of up to 8%. The overall average emission savings are 7% TTW and 2% WTW. These emission savings include any biomethane used in trial vehicles, but do not include the effects of any leakage of unburnt methane from the vehicles' tailpipes (methane slip – further details below).

[1] The ***substitution ratio*** is the percentage of energy provided by the alternative fuel (either gas or UCO) as opposed to conventional diesel
[2] **Engine efficiency** defines the relationship between the total energy contained in the fuel, and the amount of energy used to perform useful work.
[3] TTW emissions represent the CO_2 derived from the burning of fossil fuel, emitted directly from the vehicle's tailpipe
[4] WTW emissions represent TTW emissions plus the carbon intensity of the fuel production process

- Average emissions savings have been affected by some fleets experiencing relatively high efficiency losses at present. Some manufacturers are working to improve their systems which may improve fuel efficiency. A further issue is gas availability with delays in commissioning gas refuelling stations leaving fleets unable to operate on gas. This impacts on the performance of the gas trucks as they are not always able to refuel regularly and therefore need to run parts of routes on diesel only.
- Only two stations are currently supplying biomethane (with a 15% and 40% blend respectively). More extensive use of biomethane would be likely to further improve emission savings.

Dual-fuel UCO vehicles

- On average, the **dual fuel UCO** vehicles are providing a **substitution ratio** of 86% and showing no loss in engine efficiency.
- On average the WTW emissions savings are estimated at 83%

Consortium testing results

Testing undertaken by individual consortia has been reported to the trial study team. The high level results are summarised below:

Noise and Performance

One consortium was able to share results from its noise and performance testing. Test results showed that the dual fuel truck tested was significantly quieter, circa 3 dB(A), in dual fuel mode during low speed drive and acceleration events. The truck was also quieter, 0.5 - 1.2 dB(A), under idle and hot engine start conditions in dual fuel mode when compared to diesel only operation. The acceleration test shows that the truck tested was 6 seconds (12%) slower when accelerating to 50 mph in dual fuel mode compared with diesel only mode.

CO_2 and Air Quality Emissions

Some consortia have undertaken their own emission testing, using specialist professional testing houses and companies.

The dual fuel gas systems have reported direct tailpipe CO_2 emission savings of between 12 – 16%. Air quality performance has been variable with some systems showing reductions in all air quality pollutants (CO, NO, NO_2, PM, NOx) and other systems showing increases in CO and variable PM performance.

Results from testing undertaken on the UCO trucks show that PM emissions have been reduced by approximately 40%, particularly for ultrafine particles and that NOx emissions were similar between the diesel and UCO vehicles. A comparison between the trucks running on UCO and diesel showed that UCO resulted in lower fuel injector deposit formation. Chemical analysis of fuel injector deposits shows that the composition of deposits between diesel and biofuel is similar. Controlled fuel consumption testing at MIRA proving ground showed that a EURO VI vehicle operating on UCO suffered no efficiency loss when compared to diesel only operation. In fact, fuel consumption improved by around 3%.

Unburnt Hydrocarbons and Methane

Consortium testing of dual-fuel gas vehicles has shown that unburnt hydrocarbons (a proxy for methane) increase when operating in dual-fuel mode. Methane is a powerful greenhouse gas, which can reduce or potentially eliminate any carbon savings from the vehicles when ‘methane slip’ occurs during operation. In response to concerns around methane release from vehicles the DfT have commissioned a separate study which looks to develop a testing protocol to help quantify the scale of methane slip from gas-fuelled trucks. Dual-fuel system suppliers are also looking to develop effective solutions to methane emissions for both Euro V and Euro VI dual-fuel products.

The two case studies detailed below also demonstrate the work undertaken and progress to date in both providing innovative technology and delivering successful implementation:

Case Study 1 – Environmental Efficiency

The Environmental Efficiency consortium consists of Brit European as the lead partner with CNG Services providing refuelling infrastructure plus Microlise providing telemetry. The trial has delivered 36 vehicles on the road consisting of 30 CNG Dual Fuel Mercedes Hardstaff Conversions plus 6 CNG Dual Fuel - MAN Prins Conversions.

The trial has delivered the **world's first dual fuel car transporter** with innovative thinking at the heart of providing an engineering solution to locating the CNG tank on the vehicles. Brit European are now planning to buy another six Euro VI dual fuel vehicles outside of the trial.

In delivering a new refuelling station (now to be commissioned in Scunthorpe) it has taken 18 months to obtain planning permission (through change of site, issues with 3rd parties and the planning process). In learning lessons from this process Environmental Efficiency have highlighted the need to plan for earlier engagement with objectors to explain how the technology works in order to overcome objections relating to concerns about an increase in vehicle movements and the perceived safety of the technology. Mitigation measures such as vehicle curfews and educational videos have been developed to help with this.



Case Study 2 – Environmental and Performance Impact of Direct Use of Used Cooking Oil in 44-tonne trucks under real world driving conditions

The Used Cooking Oil (UCO) consortium consists of United Biscuits as the lead partner with Biomotive Fuels providing refuelling plus Leeds University providing emissions testing. The trial has delivered 10 vehicles on the road consisting of UCO Dual Fuel – Mercedes Benz Bioltec Conversions.

The project is now complete with some very encouraging data being recorded including carbon savings vs. fossil diesel of 97% being identified, totalling 2,300 tonnes of CO_2 emissions avoided. Substitution ratios of 85% have also been achieved. United Biscuits are now operating two Euro VI dual fuel trucks (UCO) outside the scope of the trial. Positive driver feedback has also been received.

Well to Wheel carbon savings are estimated at 83% with a significant reduction in particulate matter also identified.


Driver Questionnaires – mid-trial surveys

At the start of the trial, drivers completed questionnaires to ascertain their perceptions and attitudes toward the trial trucks and refuelling infrastructure. Since the pre-trial questionnaires, there has been an approximate 10% swing towards negative perceptions of the trucks. On average, 32% of drivers stated that operating the dual fuel vehicles was “more hassle than it is worth”, compared to 18% who thought they might be “more hassle than they were worth” at the pre-trial stage. Experiences vary significantly between consortia with drivers having experienced a range of issues with trucks and stations depending on their point of use within the project timeline.

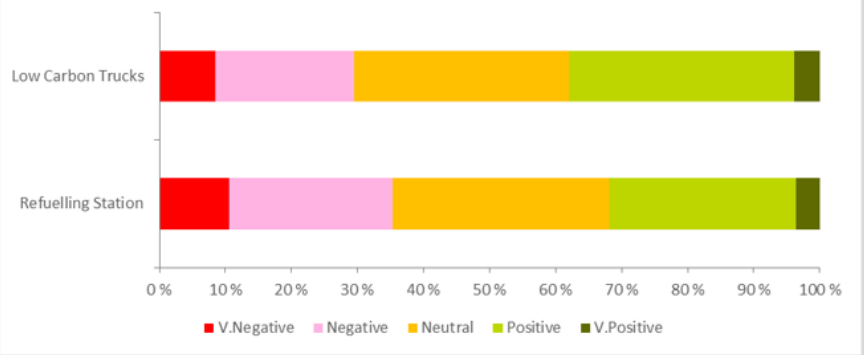
Positive comments received were mainly due to the perceived environmental performance of the trucks and the positive image this reflected on the company. Negative comments revolved around performance issues with the dual fuel gas retro-fit system and the lack of public infrastructure.

Drivers’ opinions of the gas refuelling stations was split with 35% of the drivers rating them negatively, 31% positively and 32% rating them neutrally. Drivers noted their frustration with the lack of infrastructure and the additional mileages they had to undertake to refuel, low pressures at stations preventing correct refuelling, and leaking connectors.

Dual-fuel gas

Figure 1.4 below shows that the majority of drivers have neutral and positive opinions towards the duel-fuel gas vehicles and stations. However much variation exists in driver attitude.

Figure 1.4: Driver Rating of the Low Carbon Truck and Refuelling Stations – Mid Trial



Correlation of the drivers’ comments, given perception ratings and vehicle performance data showed the following trends in driver attitudes;

- Drivers who gave **Positive** ratings believed that the trucks were good for the environment and were proud to be part of an organisation trialling and operating environmentally friendly technology.
- Drivers who operated dual-fuel gas vehicles on set repeatable trunking routes with planned access to high capacity reliable refuelling stations in reliable vehicles tended to give **Positive and Neutral** ratings.
- Drivers who rated **Negatively** cited issues with the lack of refuelling stations and were frustrated when they had to drive additional mileages off-route to refuel with gas. Some drivers noted issues with poor range performance, when running on diesel only due to the reduced tank size. Some drivers had difficulty refuelling vehicles and called for more training to be given.

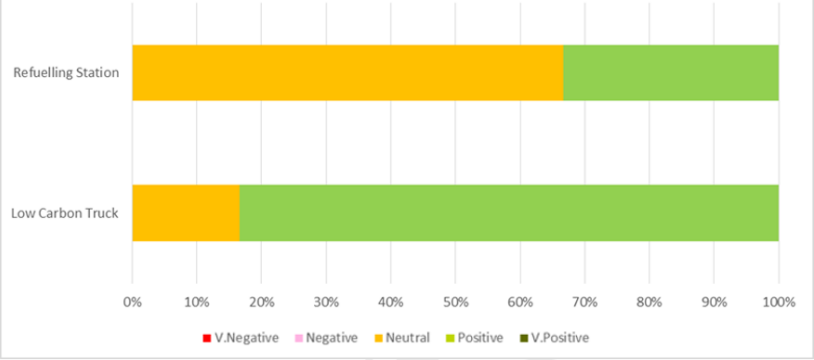
In general, the overarching sentiment from the drivers was that they felt operating gas vehicles was not as straight forward as the diesel counterparts. Drivers understood that teething troubles are to be expected in this relatively early stage of gas vehicle and station deployment.

“…once the issues are ironed out (I) believe there will be benefits across the board, duel fuel systems are great for saving money on fuel consumption and very good for reducing carbon footprint (but) there have been many teething problems”.

Dual-fuel UCO

Figure 1.5 below shows the drivers' attitudes towards the UCO trucks.

Figure 1.5: Rating the Low Carbon Truck and Refuelling Station – End of Trial (UCO)



Over 80% of drivers rated the UCO trucks positively due to the fact that they were highly comparable in operability to a standard diesel truck. Drivers rated the refuelling station as Neutral/Positive. Feedback on areas of improvement for stations centred on better nozzle design to reduce unnecessary spillages.

Key findings

The trial has now been underway for two years with some key findings beginning to emerge. The trial is demonstrating where there is improving performance, areas to note and areas where uncertainty remains and further trial data and research outside the trial might be required.

Improvements and achievements identified

- **Gas venting** – If LNG is not consumed at a sufficient rate, the vehicle tank pressure increases and the pressure needs to be reduced before the tank can be refuelled. For vehicles purchased through the trial, anecdotal evidence from trial participants comparing trial vehicles and older non-trial vehicles shows occurrences of gas venting is reducing. This is mainly due to the greater availability of LNG stations since trial commencement, meaning more regular filling and the upgrading of the older station stock being fitted with vent capture equipment. In fact, all stations funded through the trial have gas vent recovery systems in place. This means that the pressure release required from the LNG tank during a fill is released in to the station or in to dedicated vent capture cylinders. Drivers have however noted that some instances of venting are still taking place.
- **Vehicle performance** – Although most consortia have identified issues with the vehicles, these have generally been addressed by the manufacturer/conversion provider and trial participants are generally satisfied with vehicle performance reporting that the reliability of vehicles is continually improving throughout the trial. Drivers' views have however become more negative during the trial, with drivers citing issues with vehicle and station performance, although experiences seem to vary significantly between consortia.
- **UCO vehicle performance** – United Biscuits are reporting a good level of satisfaction with their UCO conversions as well as good environmental performance. In late 2014, two Euro VI trucks were converted to also run on UCO fuel (outside the trial funding). Early results are encouraging.
- **Availability of refuelling stations** – The number of stations available either publicly or through private agreements has increased over the two year period, although progress has been slower than anticipated. This has resulted in fleets being able to purchase gas vehicles and be totally reliant on public infrastructure. Four new stations (including one UCO) and six upgrades have

been commissioned through the trial to the end of 2014. Drivers and fleet managers are however still noting that a lack of station availability, and in some cases reliability, remain a barrier to further uptake of gas vehicles.

- **Availability of Euro VI vehicles** – In 2013, trial participants had expressed concerns with the availability of gas trucks in the future once the Euro VI standard entered into force. This issue is being addressed. In early 2015 five dedicated gas and two dual-fuel Euro VI vehicles are joining the trial fleet, with one dual-fuel Euro VI system being developed with trial funding during the year.
- **Improving performance** – Fleets are relocating trial vehicles to improve their performance. This is mainly to improve gas usage and substitution rates by deploying vehicles on higher mileage and higher fuel consuming duties. Vehicles are also being deployed to areas where gas prices are lower.
- **Measuring performance** – Two telematics systems have been developed through the trial that are capable of providing instant feedback on both gas and diesel fuel consumption from information on the vehicle.
- **Gas Vehicle Hub** – InnovateUK have supported the development and maintenance of the Gas Vehicle Hub website (www.gasvehiclehub.com). The Hub shows the location, specification and access arrangements of gas refuelling facilities throughout the UK.

Issues Identified

- **Methane emissions from vehicles** – Where emissions testing has taken place, some consortia report that methane slip has occurred from vehicles both with and without methane catalysts fitted. This issue is also being investigated by the DfT under a separate programme.
- **Delays in station commissioning** – There have been significant delays in station commissioning through the trial, linked to site issues, planning permission processes and technical issues. Planning barriers identified include:

    - Local objections including site location and traffic movements
    - Restrictions around highway works to allow gas infrastructure to be provided
    - Lack of clarity and consistency on planning requirements and the planning process
    - A lack of common technical standards for installations

  Delays have had an impact on the performance of the gas trucks, although this is difficult to quantify.

- **Availability of biomethane –** fleets have expressed a desire to use more biomethane. Significant well-to-wheel carbon reduction is only available with high biomethane blends in natural gas. Biomethane is in limited supply with blends of up to 40% (in 2014) being available from a limited number of refuelling stations. As well as direct biomethane use, Green Gas Certificates are available, which allow fleet operators to purchase biomethane injected in to the gas grid. However Certificates purchased in this way are not recognised under UK Greenhouse Gas reporting guidance. This is currently a key barrier to fleets wishing to reflect purchases of biomethane in their GHG reporting.
- **Technical challenges with conversions –** whilst fleets report improving reliability from the dual fuel vehicles, some technical challenges remain. The most common faults lead to the trucks operating in a diesel only mode. Fleets have also highlighted the variable quality of support between the dual-fuel gas vehicle system suppliers as an issue.
- **Issues with fuel availability and prices** - gas prices and availability can vary significantly and are linked to the availability of gas from the Avonmouth plant. 2013 saw a sharp rise in gas prices following a breakdown at this single UK supply source. Concerns here are likely to be alleviated by a new LNG terminal being brought on line at the Isle of Grain by National Grid during 2015. Consortia also report a large variation in gas price (up to 20p/kg) around the UK. Similarly, some operators reported higher operating costs from the low carbon trucks during recent (2015 Q1) falls in diesel costs.

Areas of uncertainty

Methane Emissions – Consortia report ad-hoc failures causing methane leaks from vehicle and station components and small releases of gas during station and vehicle filling events. Whilst anecdotal

evidence is being collected it has not been possible to precisely qualify the frequency and quantity of release from these events. However, these aspects are being studied as part of the Gas to Motion Study led by the Energy Technologies Institute[5].

[5] http://www.eti.co.uk/wp-content/uploads/2014/04/RfP-Gas-Well-to-Motion-Modelling-for-HDV-r1.pdf

Appendix A: Photos from Low Carbon Truck Trial

LNG Vehicle from Wisely Driven Consortium

The low carbon aerodynamic trailers from the John Lewis Partnership led consortium

CNG refuelling taking place

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