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Low Carbon Truck and Refuelling Infrastructure Demonstration Trial Evaluation

First Annual Report to the DfT
Executive Summary for publication

June 2014

Notice

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Document history

Job number: 5115327			**Document ref: First annual report to the DfT**			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1	First annual report to the DfT _Executive Summary for publication - draft	HV / SC	CW	HV	PR	28/01/2014
Rev 2	First annual report to the DfT _Executive Summary for publication	HV / SC	CW	HV	PR	10/06/2014

Executive Summary

The Office for Low Emission Vehicles (OLEV) and 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.

The funding was made available through a competition run by the TSB in 2012. 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 will also initiate publically-accessible gas refuelling infrastructure and generate a body of data to inform Government policy and industry investments through better information on 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. To support the research activity, trial consortia are required to submit vehicle performance data for a period of up to two years. 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 year of the trial

Trial vehicles

In January 2014, of the 354 trucks planned to be delivered through the trial, 175 trucks were in use, representing 49% of the total number of trucks planned through the trial. 18 low carbon trailers were also included and deployed in the trial.

As shown in Figures 1 and 2, the vast majority of trucks procured or proposed are dual fuel tractor gas trucks (either 4x2 or 6x2) apart from:

- 10 dual fuel tractor units running with used cooking oil (running);
- Five Scania dedicated LNG trucks (proposed); and
- 10 rigid 26t dual fuel trucks (proposed).

As shown in Figure 3, monitoring data was not available from all trucks on the road in December 2013/January 2014. Data was provided to the evaluation team for 115 trucks in total including partial data submissions (e.g. lacking comparator vehicle data or mileage data). Full data submissions were only available for 75 trucks (43% of trucks on the road).

Figure 1: Planned vehicles conversions (number of vehicles)

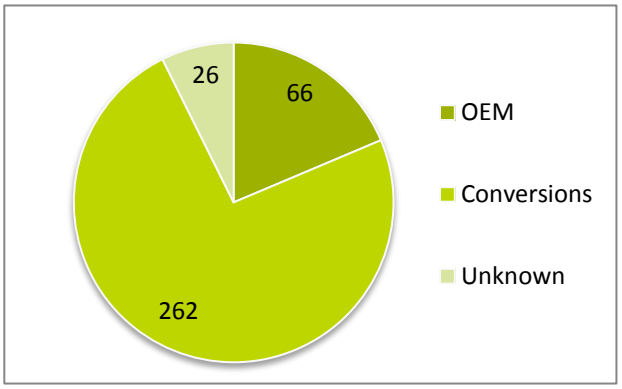


Figure 2: Planned dual fuel system (number of vehicles)

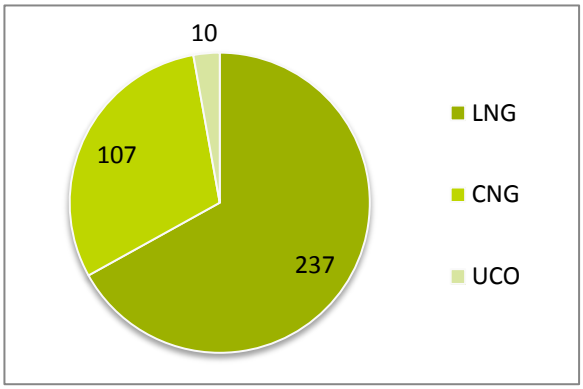
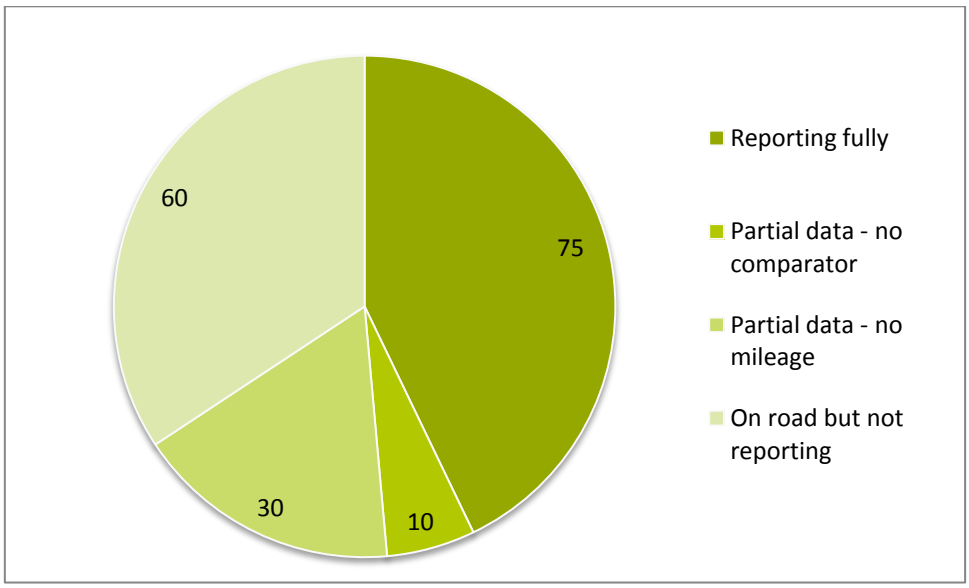


Figure 3: Number of trucks reporting monitoring data in December 2013



Refuelling infrastructure

A total of 18 new stations are planned through the trial (five LNG stations, two CNG stations, 10 LCNG stations, 1 UCO station) and eight existing stations are due to be upgraded with methane vent capture technology. In December 2013, four stations were available as part of the trial, all accessible to other users on application:

- two LNG stations at Muller-Wiseman's sites in Bellshill, Scotland and in Droitwich, Worcestershire;
- one LNG station at Stobart's site in Appleton Thorne, near Warrington; and
- one used cooking oil station at the United Biscuits' site at Ashby de la Zouch, Leicestershire.

Summary of trial consortia partners, planned vehicles and refuelling infrastructure

Consortia (lead partner)	Partners	Trial vehicles (planned)	Refuelling infrastructure
Wisely Driven Fuel Partnership (Muller-Wiseman)	Muller-Wiseman (lead partner), Chive Fuels, Cenex, Mira	40 Volvos FM, LNG dual fuel tractor units fitted by Volvo (OEM)	Two LNG stations in use at Bellshill and Droitwich Spa
GoByGas (Biomethane Ltd)	Biomethane Ltd (lead partner), Wincanton Plc and Howard Tenens	27 dual fuel trucks: 15 LNG dual fuel tractor units, Mercedes Benz Hardstaff conversions and 12 CNG dual fuel tractor units, DAF & Mercedes Benz Prins conversions	Six LCNG stations planned, locations to be confirmed
Dual Fuel Pathfinder (Stobart)	Stobart (lead partner), BOC Group	20 new LNG Volvo trucks fitted by Volvo (OEM)	LNG refuelling station in use at Appleton Thorn, Warrington
Environmental Efficiency (Brit European)	Brit European Transport (lead partner), CNG Services Limited, Microlise Ltd	30 CNG dual fuel tractor units Mercedes Benz Hardstaff conversions and 6 MAN CNG dual fuel tractor units Prins conversions	Planned CNG station, location to be confirmed
Tesco Engineering / The Hardstaff Group Dual Fuel Operational Fleet Trial (Tesco Engineering)	Tesco Engineering (lead partner) and the Hardstaff Group	35 LNG dual fuel tractor units, Mercedes Benz converted by Hardstaff	No refuelling facilities included in the trial
LCV-AMBER (The Hardstaff Group)	The Hardstaff Group (lead partner), Tesco	Plans for 35 LNG dual fuel tractor units, Mercedes Benz to be converted by Hardstaff	LCNG station planned at Avonmouth
Environmental and Performance Impact of direct use of used cooking oil (United Biscuits UK Ltd)	United Biscuits UK Ltd (lead partner), Biomotive Fuels Ltd, Leeds University	10 dual fuel Mercedes Benz tractor units using diesel and used cooking oil converted using the Bioltec system	New UCO tank commissioned in April 2013
Collaborative Ultra Low Carbon Demonstrator Vehicles (John Lewis Partnership)	John Lewis (lead partner), Howard Tenens, Lenham Storage, Cambridge University	18 CNG dual fuel tractor units, Prins conversions, and 18 aerodynamic trailers	No refuelling facilities included in the trial
ENTRIS - Evaluation for Natural Gas refuelling in Swindon (Howard Tenens)	Howard Tenens (lead partner), John Lewis Partnership, Lenham Storage, Emissions Analytical, CMS Supatrak	34 CNG dual fuel tractor units initially planned, additional 7 units ordered, DAF & Mercedes Benz Prins conversions	CNG station at Howard Tenens depot in Swindon
CNG Services Evergreen (CNG Services)	CNG Services (lead partner), Chive Fuels, DHL, KBC Logistics	31 LNG dual fuel tractor units including 1 Volvo OEM unit, 20 Volvo with Clean Air Power conversions and 10 Mercedes Benz with Prins conversions	Three new LNG stations, two depot installations and five station upgrades planned
CNG Services Magna Park (CNG Services Ltd)	CNG Services (lead partner), Gasrec, Argos, DHL, Stobart	Plans for 26 LNG vehicles including 5 LNG Scania dedicated gas (OEM), 11 LNG dual fuel Volvo Clean Air Power conversions (other vehicles TBC)	Planned LCNG station on/near Magna Park
DAF Truck (G-Volution)	G-Volution (lead partner), Container Ships (UK) Ltd	10 LNG dual fuel DAF tractor units, G-Volution conversions	Planned LNG station at Trafford Park, Manchester
Go-Truck (Container Ships (UK) Ltd)	Container Ships (UK) Ltd (lead partner), G-Volution	20 LNG dual fuel MAN tractor units, G-Volution conversions	Planned LNG station at Teesport

Trial data analysis

The performance analysis presented should be considered as provisional as it is based on a relatively small amount of data, provided by a low number of consortia over a limited period.

Several factors explain the delays in monitoring data provision including:

- some trials have not yet started;
- some consortia need to run the trucks in diesel only mode at the start of the trial to gather comparator data to be used later on in the trial to support the evaluation; and
- some consortia have faced delays in data gathering (e.g. telemetry system adjustments, adjustments to newly converted vehicles, etc).

Data on gas substitution ratio and savings in emissions is influenced by the lack of refuelling facilities or issues with facilities and gas availability during the period which result in lower than expected substitution ratio and emission savings.

Additionally, the trends observed show that vehicle performance within the fleets is improving and has not yet stabilised.

Monitoring and evaluation data

Data Protocols documents (report and spreadsheet templates) to enable the consortia to provide monitoring data to the evaluation team were issued to all consortia leads during the first year of the trial. Consortia are generally using their telematics systems to provide data and are able to provide, as a minimum, data on mileage per shift/day, fuel transferred per refuelling event and average payload per day. This allows statistics to be produced for mileage covered by the trucks, fuel consumption, gas/used cooking oil substitution rates and CO_2e performance.

Economic data

The premium cost of a dual fuel system, including the used cooking oil system, was between £4,300 and £30,000, varying according to technology chosen, vehicle make and model, integration issues and LNG/CNG tank size.

In 2013, the cost of CNG from public access third party sites ranged from 75p/kg to £1.06/kg. LNG from third party access sites ranges from £1.05/kg to £1.08/kg.

Mileage and fuel use

Across the 85 vehicles currently reporting distance data, the trial vehicles covered over 1,000,000 km per month (over 11,600 km per vehicle per month) in 2013. The average daily distance travelled per truck was 620 km.

By January 2014 the trucks for which data was available had reported covering over 4 million km and had consumed over 900,000 litres of diesel, 438,000 kg of LNG, 130,000 kg of CNG and 48,000 litres of UCO (partial reports only). This also included 41,000 kg of biomethane, saving 218,000 kg of CO_2e on a TTW basis and 86,000 kg on a WTW basis (compared to diesel only mode). As noted above, improvements in the supply of gas should result in increased gas use and lower diesel use in the future.

Substitution ratio

The average substitution ratio (the percentage of diesel fuel replaced by gas or UCO in dual fuel mode) is 46% from the dual fuel gas vehicles and 87% from the dual fuel UCO vehicles. The substitution ratios of the trucks are on an upward trend as early problems with infrastructure, fuel availability (leading to some vehicles having to cover part of their journeys in diesel only mode) and vehicle reliability are receding.

Efficiency penalty

The efficiency of the dual fuel vehicles can be compared to that of their diesel equivalents by calculating the miles covered by the dual fuel and diesel trucks when using the same amount of energy (comparison on an energy basis rather than volume basis). An efficiency loss occurs where a dual fuel vehicle covers less mileage than a standard diesel truck for the same amount of energy. The average efficiency loss due to the dual fuel systems across the trial (data only available from two consortia using LNG dual fuel systems) is 4%.

CO_2 emission savings

The first monitoring data shows that fleets are experiencing CO_2 emission savings from the gas dual fuel vehicles of up to 9% on a tank to wheel (TTW) basis and up to 6% on a well to wheel (WTW) basis. The low average emission savings are mainly due to some fleets experiencing relatively high efficiency losses at present as manufacturers are working to improve their systems, as well as additional factors such as gas availability issues (leading to some vehicles having to cover part of their journeys in diesel only mode). For UCO vehicles, TTW savings are estimated at 84% and WTW savings at 85%.

Drivers and Fleet Managers questionnaires

138 drivers have completed questionnaires so far. A very large proportion (above 80%) of drivers considered themselves as environmentally conscious and were proud to test new and alternative fuel technologies. The “first impression” questionnaires showed that drivers’ expectations of the trucks’ performance were exceeded, with 85% of the “first impression” respondents rating the new dual fuel vehicles positively.

Whilst the drivers were generally impressed with the performance of the trucks, they were more divided on the performance of the refuelling stations. 23% of “first impression” respondents had very negative opinions of the gas stations (although 17% were very positive). The negative feedback seems to support anecdotal evidence from the consortia who detailed technical, reliability and access problems with gas stations.

Consortium testing

Some consortia have included voluntary tests for noise and emissions within their trial.

One consortium was able to share early results from noise and performance testing. Test results show that the dual fuel truck tested was significantly quieter, circa 3 dB(A), in dual fuel mode during low speed drive (a 5.2% reduction) and acceleration events (reduction between 1.4 and 4.3%)-. The truck was also quieter, 0.5 - 1.2 dB(A), (reduction between 0.6 and 2%) 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.

Initial results from testing undertaken on the UCO trucks show that PM emissions have been reduced by approximately 40%, particularly for ultrafine particles. A comparison between the trucks running on biofuel and those running on standard diesel show that biofuel did not result in additional fuel injector deposit formation. In fact, a lower amount of deposits were observed on fuel injectors for UCO vehicles. Chemical analysis of fuel injector deposits shows that the composition of deposits between diesel and biofuel is similar. More detailed analysis on PM and gaseous emissions are ongoing. Additionally, carbon footprinting work undertaken shows that UCO offers a significant well-to-wheel emission saving reduction of 98% per litre of fuel compared to diesel.

Issues and lessons learnt

Low carbon vehicles

Vehicle issues identified include:

- **Uncertainty on technology choice** – with limited experience of gas vehicles in the UK, limited number of vehicle/retrofit technology suppliers and variations in vehicle profitability linked to chosen technology and vehicle, fleet size and routes/miles driven. This uncertainty has led to two consortia delaying the start of their trial to review the performance of existing trucks before making a decision;
- **Technical challenges posed by the conversion process** - When choosing to retrofit dual fuel equipment onto a tractor unit, some hauliers have experienced significant challenges to fit the tanks and required equipment whilst retaining maximum functionality (load weight, length and height, maximum capacity for gas, diesel and ad-blue tanks);
- **Issues with vehicle availability from 2014** - A number of consortia have raised concerns with regard to the availability of dual fuel trucks from 2014, linked to the introduction of Euro VI standards;
- **Issues with trial vehicles in operation** - Consortia which are operating dual fuel trucks are generally satisfied with their performance. A few teething issues were identified but have generally been addressed;
- **Air quality emissions** – Consortia have raised concerns over the uncertainty regarding air quality emissions from the dual fuel trucks and are unsure how they compare to the diesel comparator vehicles.

Refuelling stations and low carbon fuel

Issues identified with regard to refuelling stations and fuel include:

- **Delays in commissioning refuelling stations** - Consortia have experienced delays and difficulties in obtaining planning approvals for refuelling stations and commissioning the stations;
- **Issues with refuelling station performance** - No significant issues have been noted with the performance of the stations currently made available through the trial. Consortia members however noted a range of issues with existing public refuelling stations including stations being out of gas or off line with no notification to users;
- **Issues with station availability** - Several consortia note that the lack of publicly available stations in the UK results in lower substitution ratios than could ideally be achieved, with trucks having to drive on diesel only where they are not able to refuel with gas or having to drive additional distances off route to refuel;
- **Issues with fuel availability and prices** - gas prices and availability can vary significantly linked to the availability of gas from the Avonmouth plant. Operators have also expressed a desire to use more biomethane due to its lower carbon intensity
- **Green-gas certificates** - Some trial participants wish for updated Government guidance on grid-injected biomethane to be progressed further so that Green Gas Certificates (or equivalent) can be used when reporting on emissions.

Delays compounded with the relatively low number of stations available for public use in the UK, have had an impact on substitution ratios, costs, duration of shifts and staff retention for some trial participants.

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