- *This note evaluates the technology available for on-board diagnostic recordings within the Irish Truck Transport Sector (ITTS).*
- *The analysis was carried out on fuel consumption of two trucks working in the timber and general haulage sectors.*
- *By identifying the appropriate best available technology, it is hoped that the results of such truck trials can be used to inform the ITTS of the potential uses of incorporating new technologies from both a revenue per kilometre and environmental perspective with regard to fuel savings and CO_2 savings due to increased fuel economy.*
- *Fleet engine diagnostic technology is relatively new to the ITTS and it is hoped that this work will assist truck companies in making informed decisions based on potential savings and return on investments.*

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Fuel consumption of timber haulage versus general haulage

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Background

In 2007, the road freight transport sector in Ireland had the highest increase in CO_2 (carbon dioxide) emissions across all sectors, at 182% above 1990 levels. From 1990 to 2007 the total CO_2 emissions in transport, thermal and electricity increased by 51%, with transport accounting for 36% (Howley et al. 2008), and CO_2 being the most dominant of the greenhouse gas emissions (GHGs).

In the USA, trucks account for over 80% of the freight energy use and 19% of US oil consumption. Plans to improve the technical efficiency through new technologies, careful driving and optimal driving conditions have obtained increased efficiencies between 50 and 70% (Komor 1995). Bandivadekar et al. (2008) believe that the increase in the consumption of oil for transport in the USA is a challenging environmental problem that needs to be addressed based on reducing fuel consumption through driver behaviour rather than concentrating on improving vehicle performance through new propulsion technologies and new fuels in the shorter term. Similar studies in Mexico by Mercedes and Cervantes de Gortar (2002) demonstrated that technical driving through optimal use of engine speed and torque brought about substantial savings in fuel consumption and pollutant emissions.

The rising cost of road diesel accounts for the majority of a haulier's overall costs. In Sweden, diesel costs rose sharply in 2008 and today accounts for 35% of total operating costs for timber haulage. Ten years ago, this figure was between 10 and 15%. According to Lofroth et al. (2008), the average fuel consumption of Swedish roundwood haulage rigs is a very low 0.83 mpg (US). This is equivalent to approximately 1 mpg or 0.29 km/l (UK Imperial). This study showed values ranging from 1.1 km/l to 4.53 km/l (UK Imperial).

Other factors such as higher truck axle configurations and higher payload weights in Sweden must be studied when comparing the fuel consumption of the Irish and Swedish timber haulage sectors. Lofroth and Lindholm (2005) believe that haulage trucks can reduce their fuel consumption by between 5 and 10% simply by fitting a wind deflector and removing all unnecessary items such as signboards, extra air horns, extra lamps and other accessories that can increase drag.

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In Japan, Yoshioka et al. 2006 examined a system for the harvesting and transporting of logging residues based on cost, energy and CO_2 compared with those of European countries. It was demonstrated that Japan could only reduce the domestic CO_2 emissions of the harvesting and transporting system by utilising the collected residues as an alternative fuel source. Savings within the system itself could only potentially be achieved with improving and advancing the technical developments of forwarding and transport efficiency. A solution to Yoshioka's study might revolve around the world's first new electric hybrid forwarder (Lofroth et al. 2007). The fuel consumption of the forwarder was 20-50% lower than that of a conventional forwarder. It has a small diesel engine that runs a generator that can charge six batteries to provide the back up power to six electric motors in each of the six wheels. It also has a lower unladen weight which implies a higher weight to payload ratio.

At the Forest Engineering Group (FEG) conference in Scotland in 2009, Dr Jan Fryk (President of Skogforsk) stated that "to reduce the carbon footprint in timber harvesting, we must reduce fuel consumption from 3.7 litres/m^3 to 2.1 litres/m^3".

Other possible solutions to reducing fuel consumption and the effects of increased GHG exhaust emissions is to preplan and optimise the routes travelled by the trucks (Devlin et al. 2007, 2008). Frisk and Ronnqvist (2005) developed a decision support system to optimise the wood flow planning in Sweden and found that roundwood haulage costs could be cut by up to 5%. Tavares et al. (2009) incorporated geographic information systems (GIS) software to model and preplan routes for the collection of municipal solid waste (MSW) in the city of Praia, Cape Verde. The GIS modelled the fuel reduction routes with results of 8 and 12% savings in fuel consumption versus previously travelled routes.

This note evaluates the technology available for on-board diagnostic recordings within the Irish Truck Transport Sector (ITTS). The analysis looked at fuel consumption of two trucks, one working in the timber sector and the other working in general haulage sector. By identifying the appropriate best available technology, it is hoped that the results of such truck trials can be used to inform the ITTS of the potential uses of incorporating new technologies from both a revenue per kilometre and environmental perspective with regard to fuel savings and CO_2 savings due to increased fuel economy and efficiency. Fleet engine diagnostic technology is relatively new to the ITTS and it is hoped that this work will assist truck companies in making informed decisions based on potential savings and return on investments.

Introduction

One of the recommendations in the FITG (Forest Industry Transport Group) Code of Practice for Timber Haulage was to "encourage closer co-operation between consignors and hauliers to plan routes in a manner which optimises the economic returns within a legal framework". The GPSTRACK project started as a result: Assessment of GPS tracking devices and associated software (fuel consumption) suitable for real time monitoring of timber haulage trucks. The work is a significant step in the overall integration of Information Technology into the Irish forest industry. Specifically, the work, carried out in collaboration with industry and the FITG, assessed the potential for the use of GPS asset tracking devices from an economic perspective by comparing the timber truck fuel consumption performance with that of a general haulage truck, and to develop expert recommendations regarding usefulness of GPS and engine diagnostic devices in timber haulage.

The project involved the installation of one GPS asset tracking and engine diagnostic system– referred to as System A - onto a timber haulage truck (Iveco Stralis) and a general haulage truck (DAF XF).

– an articulated Iveco Stralis 530 6*2 tractor unit with tri-axle road-friendly air suspension flat bed trailer with a design gross vehicle weight (d.g.v.w.) equal to 44,000 kg;

– a DAF XF 430 4*2 tractor unit with tri-axle road friendly air suspension curtain side trailer with a d.g.v.w equal to 42,000kg.

The Iveco Stralis (timber haulage - Figure 1) and a DAF XF (general haulage - Figure 2) were monitored for criteria including:

- distance travelled,
- fuel used,
- km/l,
- diesel CO_2 emissions,
- biodiesel CO_2 emissions.

Figure 1: Iveco Stralis 530 articulated configuration.

Figure 2: DAF XF is to the left.

System A connects into the FMS of each truck and records valuable engine diagnostic information such as accurate fuel data, fuel used, miles per gallon (mpg), kilometre per litre (km/l), amount of fuel in diesel tank, harsh braking, over speeding, maximum revs per minute (rpm) and idling etc. System A can connect to any FMS of any truck manufacturer's engine so there are no limits to recording the engine and driver performance data. System A cannot record fuel used, fuel in diesel tank or km/l for trucks older than 1999 as the trucks do not have the Fleet Management System for the System A hardware to connect to. (Please contact ger.devlin@ucd.ie for suitability of particular truck make and models.)

Figure 3 shows extremely low km/l, which implies high fuel consumption resulting in increased cost per kilometre and thus a decreased revenue per kilometre. Low km/l implies more litres of diesel used and consequently more kilograms of CO_2 emitted into the atmosphere based on the fact that approximately 2.67 kg of CO_2 is emitted per litre of diesel burned. If the fossil fuel mineral diesel was completely replaced with a biodiesel then CO_2 emissions could be reduced by approximately 27% as biodiesel has a smaller carbon footprint than regular diesel. Figure 4 shows the corresponding graph of fuel litres consumed for both trucks. High km/l implies low fuel consumption and good fuel efficiency.

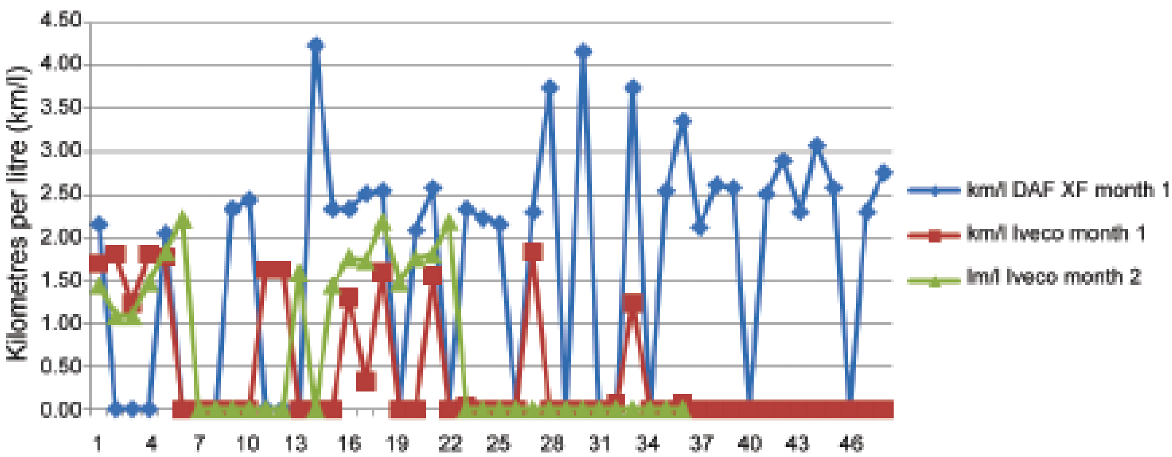

Figure 3: Km/l of Daf XF (general) vs Iveco Stralis (timber).

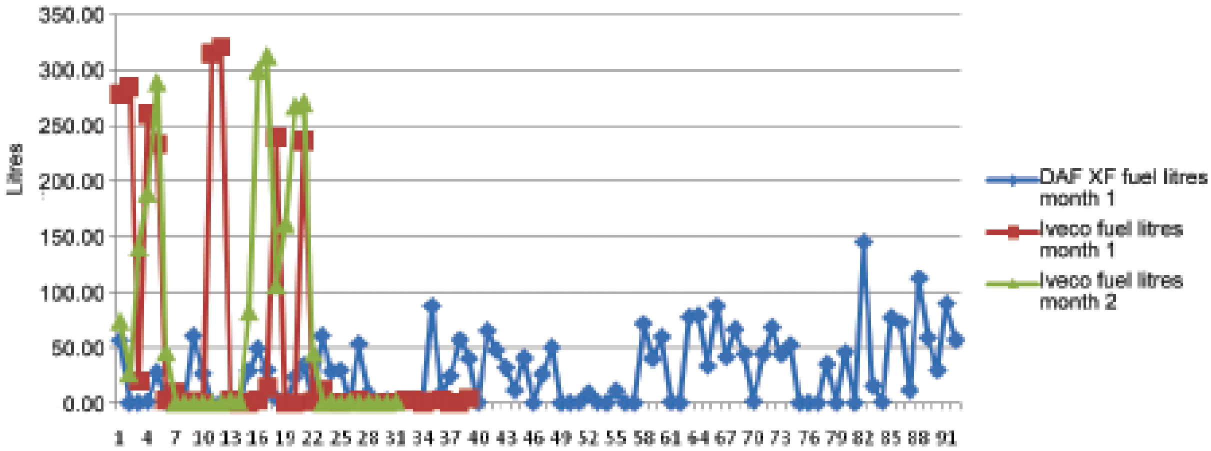

Figure 4: Fuel litres used by Daf XF vs Iveco Stralis.

To summarise exactly what all the graphs are showing, Table 1 compares both forms of haulage and shows that the km/l of the Daf XF reaches at best 4.53 km/l. This value is more than double the best km/l of the Iveco at only 2.23 km/l. The corresponding miles per gallon (mpg) are entered for reference purposes.

Conclusions

The DAF XF in this study travelled 79% more kilometres than the Iveco in month 1 and approximately 68% more kilometres than the Iveco in month 2, yet only burned 15% and 12% more litres of fuel respectively.

Table 1: General haulage versus timber haulage.

	General haulage	Timber haulage	
	Month 1	Month 1	Month 2
Highest km/litre	4.53	1.80	2.23
Lowest km/litre	2.16	1.24	1.10
Average km / litre	3.34	1.52	1.66
Highest mpg	12.8	5.1	6.3
Lowest mpg	6.1	3.5	3.1
Average mpg	9.45	4.3	4.7
Distance (miles)	4140.3	2306.8	2459.5
Distance (km)	6661.74	3711.64	3957.34
Gallons	573.07	496.66	511.36
Litres	2604.86	2257.54	2324.37
Cost of diesel (€) inc vat (90 cent/litre)	2,344.37	2,031.79	2,091.93
CO_2 emissions p/m (kg)	6,954.98	6,027.63	6,206.07
Potential savings p/m euros	-	312.59	252.44
Potential savings p/a euros	-	3751.05	3029.29
Potential reduced CO_2 (kg) p/a	-	11,128.13	8,986.90

Thus in general haulage, more kilometres travelled for less diesel burned means more revenue per kilometre. Other factors to consider include the difference in the cost of diesel due to poor km/l at approximately €312/month and €252/month for the timber haulage truck which equates to €3751/year and €3029/year (taking €0.90 per litre of diesel including VAT at 21.5% October 2009 prices). Diesel prices are now approximately €1.20 per litre including VAT at 21% (VAT rate reduced from 21.5% to 21% from 1 January 2010 but the newly introduced Carbon Tax has generally increased the price of diesel). If looking at return on investment for installing the equipment, it would be of the order of one year if fuel performance in timber haulage matched that of general haulage.

The amount of CO_2 emissions that could also be displaced from the atmosphere if the Iveco was operating at the higher km/l similar to that of the DAF XF is approximately 9,000 kg for Month 1 and 11,000 kg for Month 2.

This adds to the importance of environmental considerations and the concept of eco-friendly truck driving to Ireland's commitment to reducing CO_2 levels to 13% above 1990 levels under the Kyoto Protocol. The transport share of energy-related CO_2 emissions accounted for 36% of the total primary energy supply in 2007. Road freight recorded the largest growth from 1990 to 2007 with CO_2 emissions 182% higher in 2007 than in 1990. Growth in 2007 was 5.3%, slightly below the rate of economic growth of 6%.

The main reasons for relatively poor fuel economy for timber haulage revolves around four areas:

- Make and model of trucks used in the trial;
- New versus old trucks;
- Overloading of timber - exceeding the d.g.v.w. for optimum revenue per kilometre;
- Travelling on the varying gradients of internal forest road network versus more truck-friendly public roads.

Therefore the biggest cost to timber haulage is fuel due to poor lower km/l as a result of driving on the internal forest road versus the main roads for general haulage. For timber haulage to be cost competitive, the price of diesel needs to decrease. Different scenarios include where, for example, if forwarders can stack timber closer to the forest entrances thus allowing savings to be made by trucks not travelling on forest roads. The fuel performance of the forwarder versus the consumption the truck would have to be monitored here to exactly quantify this but immediate savings would include the consumption of agri-diesel of the forwarder versus the consumption of the truck. This would also lead to increased possibilities of less road damage as a result of no truck traffic.

Possibilities to incorporate the blending and use of biodiesel to reduce fuel costs could also be addressed. Under the Biofuels for Transport scheme and EU Biofuels Directive, the government have established a Mineral Oil Tax Relief (MOTR) scheme where providers of biodiesel can sell to customers without any Government tax, thus reducing the cost per litre of diesel versus the price of fossil fuel road diesel. Limitations of the biodiesel imply that it can only be blended with EN590 standard diesel as most biodiesel on the market is made from rapeseed oil (OSR) or recovered vegetable oil (RVO) as a First Generation Biofuel and cannot be a 100% direct substitute for EN590 diesel just yet. First generation biofuels can only be used as a blended fuel with EN 590 fossil fuel diesel so at this time a 100% substitute cannot be achieved. Maximum blends are approximately 10-15% biodiesel and 85-90% EN590 diesel. However, new conversion technologies are making a 100% blend possible. For example, the Bioresources Research Centre at UCD is currently trialling the use of synthetic diesel fuel made from plastic at a blend of 70:30 (diesel:syn-diesel) in three 4*4 vehicles where no engine modifcations are needed to use the synthetic diesel. Future work could include trialling this fuel in trucks and looking at increasing blends to perhaps 50:50. (For more information on this work, contact ger.devlin@ucd.ie).

Future work on developing on-board weigh sensors to allow the monitoring of payload weights of articulated trucks in real-time should help to determine the reasons behind such low km/l in the timber haulage sector and generate ideas and suggestions on how to improve and increase fuel economy for a more cost effective timber haulage sector.

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