Biofuels: The Motor Industry Perspective

Biofuels: Technology meets strategy

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Presented by: David Lemon

Introduction

- The introduction of biofuels for road transport poses the following questions:
  - What supporting infrastructure is required?
  - Does the existing transport system accept the new “fuel” readily
  - What is the overall energy efficiency?
  - What is the greenhouse gas overhead?
  - What policy and fiscal support is there?

Development of UK biofuel market

Year	Biodiesel	Total Derv	Biodiesel share	Bioethanol	Total Petrol	Bioethanol share	Biofuel share
	ktonnes	ktonnes	%	ktonnes	ktonnes	%	%
2002	2.3	16,431	0.01	0.0	20,620	0.00	0.01
2003	16.2	17,378	0.09	0.0	20,172	0.00	0.04
2004	17.4	18,438	0.09	0.0	19,901	0.00	0.05
2005	27.3	19,313	0.14	62.9	18,920	0.33	0.24
2006	140.4	20,188	0.70	70.1	18,206	0.39	0.55
2007	280.0	20,831	1.34	105.0	17,729	0.59	1.00

Source: HMRC

UK road fuel refuelling infrastructure 2007

Refuelling type	Number	Percentage of total	Change on 2006
Diesel + Petrol	9721	100%	- 1.1%
Biodiesel	949	9.8%	+ 100%
Bioethanol	578	5.9%	+ 219%

Source: Petroleum Review

UK transport biofuels yields

Biofuel	Process	Yield	Moisture	Unit delivered energy
		t/ha/yr	percent	MJ/ha/yr
Biodiesel	Oilseed rape	3.1	15%	40,335
Biodiesel + plant residue for heat	Oilseed rape	3.1	15%	99,849
Bioethanol	Wheat grain (starch)	8.6	20%	67,085
Bioethanol + wheat straw to heat	Wheat grain (starch)	8.6	20%	148,825
Bioethanol	Sugar beet (sugar)	52.1		117,105

Source: Royal Society

Transport fuels WTW GHG
EUCAR / JRC / CONCAWE Study
VW Golf comparison

Fuel or energy vector	Technology	Pathway	Well-To-Tank GHG	Tank-To- Wheels GHG	Well-To-Wheels GHG
			gCO2e / km	gCO2e / km	gCO2e / km
Gasoline	PISI	Fossil	24	140	164
Bioethanol	PISI	Sugar beet pulp to heat	- 26	136	110
Bioethanol	PISI	Wheat straw	- 119	137	18
Bioethanol	PISI	Sugar cane	- 116	137	22
Biomethanol	PISI	Wood / Black liquor	- 112	118	6
CNG	PISI	Fossil EU-mix	16	108	124
Biomethane	PISI	Municipal waste	- 76	108	32
Biomethane	PISI	Dry manure	- 103	108	5
Biomethane	PISI	Liquid manure	- 250	108	- 143
Diesel	DICI	Fossil	25	131	156
RME	DICI	Glycerine as chemical	- 51	133	82
Syn Diesel	DICI	Wood / black liquor	- 118	124	6
DME	DICI	Wood / black liquor	- 112	118	6
CH_2	PISI	Wood / black liquor	17	0	17
CH_2	Fuel cell	Wood / Black liquor	9	0	9
CH_2	Fuel cell	Electrolysis from nuclear	12	0	12

Travel energy efficiency

Method of travel	gCO2 / passenger-kilometre
Underground	53
Rail	60
Bus	89
Car	130
Domestic flight	158

Source: DfT / AEA Energy & Environment

EU biofuel targets

- The EU Renewable Energy Directive (RED) has set targets for biofuel energy content in transport fuels as follows:
  - 2005 - 2%
  - 2010 - 5.75%
  - 2020 - 10%
- Only Sweden and Germany met the 2005 target and it is forecast that most of the 27 member states are likely to miss the 2010 target
- The EU Fuel Quality Directive requires a 10 percent reduction in average life-cycle emissions of fuels between 2010 and 2020 – fuels suppliers are responsible for delivering this target

EU fiscal incentives for biofuel post RED

Country	Biodiesel	Bioethanol	E85	2nd generation
Estonia	Zero rated	Zero rated		
Finland	Zero incentive	Zero incentive		
France	€ 0.25	€ 0.33	€ 0.5858	
Germany	€ 0.4704 (zero rated)	€ 0.6545 (zero rated)	Zero rated to 2015	Zero rated to 2015
Hungary	€ 0.36 (zero rated)	€ 0.427 (zero rated)		
Ireland	Zero rated	Zero rated		
Lithuania	Zero rated	Zero rated		
Malta	Zero rated	Zero rated		
Netherlands	Zero incentive	Zero incentive		
Poland	€ 0.28 (nearly zero rated)	€ 0.41 (nearly zero rated)		
Portugal	1% of fuel market 100% zero rated	1% of fuel market 100% zero rated		
Spain	Zero rated to 2012	Zero rated to 2012		
Sweden	€ 0.373	€ 0.559		
UK	€ 0.29	€ 0.29		

Source: e-bio + FAS

UK Renewable Transport Fuels Obligation (1)

- The Renewable Transport Fuel Obligation programme commenced in April 2008 in the UK
- It places an obligation on fuel suppliers to ensure that a certain percentage of their aggregate sales is made up of biofuels
- The scheme is administered by the Renewable Fuels Authority (RFA) on behalf of the UK Government
- In order to ensure compliance the Administrator will issue RTF Certificates according to the quantity of renewable fuel on which duty has been paid
- It will be possible for companies to trade certificates
- If a company cannot produce enough certificates at the end of each compliance period it will have to pay a “buy-out” price which will go into a buy out fund

UK Renewable Transport Fuels Obligation (2)

- The following fiscal incentives are extant at the commencement of the RTFO:
  - Fuel duty differential = 20p / litre
  - Buy-out = 15p / litre
  - Total incentive = 35p / litre
- In year 2010-2011 the total incentive is set to drop to 30p / litre
  - Fuel duty differential = 0p / litre
  - Buy-out = 30p / litre
- Targets for bio-fuel content by volume are as follows:
  - 2008-2009 = 2.5%
  - 2009-2010 = 3.75%
  - 2010-2011 = 5.0%

UK Renewable Transport Fuels Obligation (3)

- **Industry criticism following Budget 2008 confirmation of zero fuel duty differential in 2010 ahead of any operating experience of the RTFO**

Effect of BSOG

- Bus Service Operators' Grant is a barrier to the introduction of low carbon / low emissions buses in the UK
  - Rebates 80% of fuel duty on a "fuel used" basis and therefore does not reward improved fuel economy
  - Favours fossil derived diesel at the expense of biofuels as the fuel duty differentials for biofuels are diluted
- DfT consultation taking place during Q1 & Q2 2008

Bioethanol

- Older spark ignition cars only have tolerance for 5% ethanol / gasoline blend (E5)
- New cars have a tolerance for 10% blend (E10)
- “Flexi-fuel” cars are now available in the UK and can run on up to 85% blend (E85) or 100% gasoline (special components)
- Fuel consumption on a volumetric basis is worse compared to gasoline by a factor of circa 1.5 for pure ethanol (circa 1.4 for E85)
- Bioethanol has been successfully run in Sweden on fleets of buses with specially modified Scania compression ignition engines
  - The fuel contains 92.2% ethanol with the rest of the content comprising an additive pack including a cetane improver
  - Fuel consumption is worse compared to diesel fuel by a factor of circa 1.8 on a volumetric basis
- Some sources claim that up to 7% ethanol may be blended with diesel fuel for conventional engines

Biobutanol

- BP has been proactive in the promotion of butanol as an alternative to ethanol as a gasoline substitute and gives the following reasons:
- Non-corrosive
- May be used in higher concentrations in gasoline blends
  - 17% compared to 10% maximum of ethanol in standard new cars
- Low water affinity
  - No risk of phase separation
  - May use existing pipelines
- Ease of blending
  - No vapour pressure issues
- Higher energy content
  - 86% versus gasoline c.f. 67% for ethanol versus gasoline

Biodiesel

- Unlike ethanol and butanol biodiesel does not have a consistent chemistry
- European heavy duty engine manufacturers have limited fuel biodiesel content to 5% (B5) as a general requirement to maintain warranties
  - This is mainly at the behest of the fuel injection equipment manufacturers
- Scania and DAF recently announced that 100% bio-diesel made from rapeseed methyl ester (RME) and conforming to the EN14214 standard may be used in new engines that have more tolerant components
  - A more stringent maintenance programme must also be followed which includes halving intervals between oil and filter changes and inspection of seals on a regular basis
  - Renault are more cautious and only allow 30% blend (B30) at the moment
- Synthetic diesel removes all of the difficulties and provides superior characteristics to today's standard fuel at a projected renewability factor of 80%

Biogas

- Biogas requires significant changes to the vehicle and at a high cost premium compared to the standard diesel vehicle
- There is currently an extremely limited new vehicle availability in UK
  - M-B Econic refuse truck
  - IVECO Daily van
  - M-B Sprinter van
- There is a very small existing vehicle fleet of circa 500 in the UK
- The refuelling infrastructure is also very limited in the UK with only some half dozen compressor stations still active
- Compressor stations are expensive
- Great interest in the UK for this fuel as it provides a means of using circa 60% of the municipal waste through an anaerobic digester process

Hydrogen (1)

- Hydrogen may be used to operate a spark ignition engine similar to those that run on gasoline or methane (H2ICE)
  - To effect the same range as existing fossil fuel designs the hydrogen requires to be compressed to 700 bar
  - This is not without concerns regarding sealing and safety
  - There is a significant energy loss associated with the compression
  - Current practice is to run tanks at 350 bar with the consequent halving of range
- Hydrogen tanks are extremely expensive which leads to the overall cost of the technology being very high

Hydrogen (2)

- Hydrogen may also be used for fuel cells
  - The PEM type is favourite for light duty vehicles but still does not have sufficient life for heavy duty applications
  - The cost of the fuel cell technology is also rather high compared to the well developed and extremely low cost gasoline spark ignition engine
- The hydrogen refuelling infrastructure is extremely expensive due to the technical challenges of containing such a searching fluid and there are considerable H & S requirements above and beyond those for conventional filling stations

Transport fuel operations comparison

	Existing fleet use?	Refuelling	Infrastructure on-cost	Vehicle on-cost
Synthetic fuel	Yes	Existing	None	None
Biodiesel	Blend 5%	Existing	None	None
Bioethanol	Blend 5% - 10% Blend 85%	Existing New	None Low	None Low
Biobutanol	Blend 17%	Existing	None	None
Biogas	No	New	Medium	Medium
DME	No	New	Low	Low
Methanol	No	New	Low	Low
Hydrogen	No	New	High	High
Electricity	No	Existing	None	Low

King Review (1)

The King Review of Low Carbon Cars Part I (October 2007) reported the following important points of relevance for biofuels:

- **Forecasted that renewable transport fuels may contribute 10% (range 5% - 15%) by 2030**
- **Ensuring the sustainable development of biofuels is critical**
- **Land requirements of biofuels are high and rapid expansion of production risks adverse environmental impacts from changing land use as well as increased food prices**
- **Future biofuel technology has great potential to reduce land and water requirements and deliver much greater CO2 savings**
- **There are significant difficulties with measuring and monitoring life-cycle CO2 emissions of fuels and establishing an agreed methodology for measuring LCEs of fuels will be a key step towards a policy framework that cost-effectively reduces CO2 from fuels**
- **Transport is currently one of the least cost-effective uses of biomass in saving CO2 and in general using biomass for heat and power saves CO2 more cost-effectively**

King Review (2)

- Conversion of land can have major costs depending on the previous use for the land
- Forests and grasslands 'lock-up' large amounts of CO2 in their plants and soil and the CO2 is released if they are converted to other uses and it is estimated that if forested land is cleared then two to nine times more CO2 is released than would be saved by using the equivalent area of land to grow biofuels for 30 years

The King Review Part II (March 2008) made recommendations for biofuels which included the following:

- The DfT should assess the case for a mandate to reduce the carbon intensity of the fuel mix covering all fuels, through a Low Carbon Transport Fuel Obligation
- The UK Government should assess the case for inclusion of road transport in trading schemes such as the EU Emissions Trading Scheme (with fuels suppliers as the regulated entity)
- To reduce the risk of damaging land-use change from large increases in biofuels production the EU Fuel Quality Directive target on CO2 (requiring a 10 percent reduction in carbon intensity of fuels by 2020) should be revised downwards and a gentler compliance trajectory be implemented

King Review (3)

- The DfT should lead on developing an agreed EU methodology for measuring land efficiency of a biofuel and consider how this might be reflected in policy options within the RTFO and EU targets
- The European Commission should conduct a study to assess the cost-effectiveness of different measures to enable biofuels of 10 percent or greater by energy content – reporting before 2010 – and use this to inform any future decisions on vehicle and fuel specifications