Atlantic Consulting

LPG, biopropane and low-carbon transport

Proposals for DfT's Alternative Fuels Working Group

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1 LPG and biopropane can play a significant role

The Department for Transport's Task Force 5 has been asked to propose

- Ways to meet the UK's 2020 target of 10% renewable transport fuels
- Ways to reduce transport's carbon emissions
- A role for alternative fuels, especially biomethane, but also LPG (liquefied petroleum gas) and biopropane.

This document proposes that the Government:

Substitute LPG for petrol and diesel to reduce transport carbon emissions. According to the latest figures published by the European Commission, LPG is 21-23% lower carbon than petrol or diesel. LPG's penetration in UK transport is very low, yet could be much higher, as it already is in countries such as Germany, the Netherlands, Italy, Turkey and South Korea. UK infrastructure and supply chain are already in place. LPG is widely available at a discount to petrol and diesel, and its price relative to other fuels is expected to decline. Each 5% increase in penetration of LPG as a transport fuel (from its current level of 0.5%) would cut UK transport carbon emissions by approximately 1%.

Increase renewable transport fuel usage, and also cut carbon, by adopting biopropane under the RTFO. Some 40,000-50,000 tonnes of biopropane could be available to the UK as of 2016. This renewable fuel cuts carbon emissions 90% below those of the diesel or petrol it replaces.

Reduce smog, as a side-effect of the above measures. LPG and biopropane have significantly lower emissions of nitrogen oxides (NOx) and particle matter (PM) than do diesel and petrol. These local-air-quality pollutants are known to be hazardous to the health of humans, animals and plants. Recent figures show that air pollution levels in London, Birmingham, and Leeds will exceed European limits until at least 2030.

Position LPG and biopropane to complement biomethane in transport. Biomethane offers significant carbon savings, but it will take substantial time and money to integrate it into the transport system. LPG is widely available already, biopropane soon will be; they can play a leading role in a longer-term shift towards gaseous fuels.

2 Substitute LPG for petrol and diesel, to cut carbon emissions

According to rules issued recently as part of the EU's Fuel Quality Directive, substituting LPG's for diesel achieves a carbon saving[1] of 23%, whilst substituting it for petrol saves 21%. Changing all British cars to LPG would single-handedly come close to achieving the EU's targeted 20/20/20 carbon reductions in transport.

Although a complete changeover appears unlikely, any increase in substitution would proportionately achieve the 20%-reduction goal. And clearly, there is room for increased substitution from today's low level. A number of other countries use much more LPG in cars, so it is definitely feasible. British infrastructure for LPG is in place. The fuel's supply and cost positions have never been more favourable.

2.1 21-23% cut in GHG emissions

As part of its ongoing work to reduce carbon emissions, the European Commission sponsors and monitors research in carbon intensities of fuels, i.e. the amount of greenhouse gases they emit in delivering equal amounts of energy. Much of this work is done by the EU's Joint Research Centre Institute for Energy and Transport[2], under the auspices of its 'Well-to-Wheels' programme.

These carbon intensities are always a topic of ongoing research. In the past year or two, they have been recalculated with particular attention to their 'well-to-tank' emissions, which turned out to be much larger than was previously assumed.

These new carbon intensities (Table 1), published in an annex to the Fuel Quality Directive (European Commission 2014), have been accepted by the Commission under its revision of the Directive, which will enter into force in the first quarter of 2015, and thereafter must be transposed into national law in EU member states..

Table 1: Carbon intensities of major fuels

Fuel	g CO_2e/MJ	% reduction to diesel	% reduction to petrol
Diesel	95.1	0%	
Petrol	93.3	2%	0%
LNG	74.5	22%	20%
LPG	73.6	23%	21%
CNG	69.3	27%	26%

2.2 UK penetration of LPG could be much higher

About 99% of UK road vehicles are powered by petrol or diesel (UK Dept of Energy & Climate Change, 2014, p 11, Table 1). Currently LPG is used in about 150,000 UK vehicles. Of a total British car fleet of some 30 million, this amounts to 0.5%.

Penetration of LPG could be much higher. The EU average is 3%, with Italy at 5%, the Netherlands at 3%, and several of the eastern countries substantially higher. Bulgaria, Poland

[1] As defined in Annex V.C.4 of the Renewable Energy Directive, i.e. (carbon intensity of diesel/petrol minus carbon intensity of LPG)/carbon intensity of diesel/petrol. Carbon intensity is the carbon dioxide equivalent emitted unit of energy used, i.e. in this case CO_2e/MJ. It also could be called a carbon footprint.

[2] http://iet.jrc.ec.europa.eu/about-jec/welcome-jec-website

and Lithuania are at 17%, 15% and 13% respectively. Germany has recently moved towards LPG, with a current fleet of some 500,000 cars. Outside Europe, Turkey has the world's highest penetration rate, about 40%. In South Korea, LPG fuels over 2 million vehicles, about 15% of its total.

2.3 Existing infrastructure, plentiful supply, and declining cost

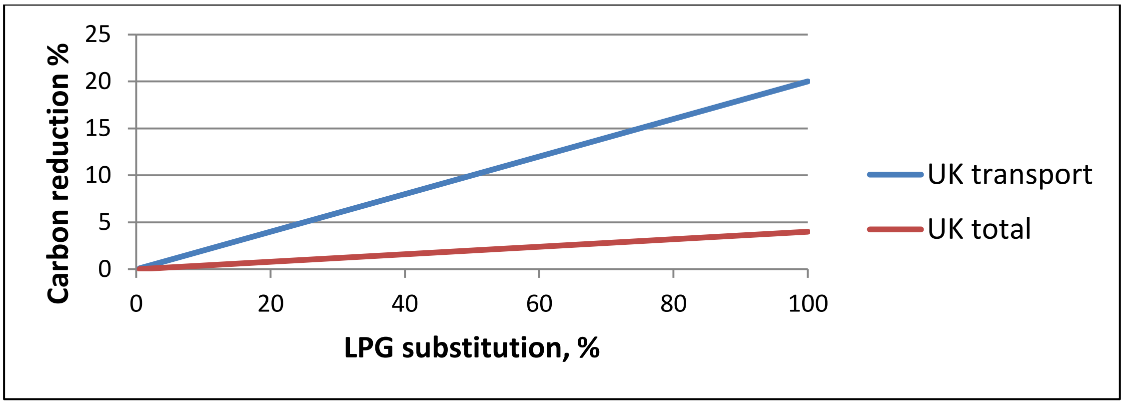
The UK has a well-developed supply chain for LPG in transport. LPG distributors receive and store product from domestic and international production, and forward this onward to domestic and industrial users (mainly for heating) as well as to around 1,400 filling stations, where it is sold under the label of autogas. Motorists can travel throughout the country with LPG, secure that they will have adequate fuel, thanks to two safeguards: 1) the broad network of filling stations; and 2) the back-up function of bi-fuelling, i.e. all LPG cars can run on either LPG or petrol, and can automatically be switched from one to the other by the vehicle's control system.

Supply of LPG is more plentiful than ever before in history, and it is expanding rapidly. This is being driven by two main trends. First, over the past decade, production by Qatar and the United Arab Emirates has soared. Both have tapped into the 'North Field' in the Persian Gulf, which is one of the world's largest-ever reserves of gas and gas liquids[3]. Together they have quadrupled exports over the past 15 years, now accounting for about one-third of global exports. Second, over the past five years, US exports have gone from almost negligible to one-third of the world total, and this will climb to some 40% by 2020. The source is hydrofracturing (commonly called 'fracking'), which has vastly increased American hydrocarbon output. Fracking now accounts for about one-third of US hydrocarbon production, which in 2012-13 surpassed that of Russia to become number one in the world. This surfeit of supply keeps prices down, relative to those of competing fuels.

2.4 How much carbon could LPG-substitution save?

Road transport is the second-largest source of greenhouse gas emissions in the UK. It emits nearly 20% of UK carbon, right behind power plants, which account for about 25% (UK Dept for Transport 2012) (UK Dept of Climate Change, 2013). Each 5% increase in penetration of LPG as a transport fuel (from its current level of 0.5%) would cut UK transport carbon emissions by approximately 1%, and cut UK total carbon emissions by 0.2%.

Figure 1: Carbon reduction possible through LPG substitution of petrol and diesel



[3] LPG consists mainly of propane and butane. It is a subset of gas liquids, which consist mainly of ethane, propane and butane.

3 Adopt biopropane, to boost renewables usage and to cut carbon

Biopropane, a renewable fuel, is a drop-in replacement for conventional LPG that will be available in 2016. Because it is produced from a residue[4], it has the potential to be double-counted in national renewables accounts. It offers a carbon saving of about 90% to petrol and diesel.

Production will start in the Port of Rotterdam, from whence it easily can be exported. Biopropane will flow to whichever country offers the best terms for it. In the UK, those terms are most likely to come via the RTFO.

3.1 Biopropane: available in 2016

Biopropane is propane[5] (C_3H_8) made from renewable feedstocks, typically vegetable oils or animal fats. It is available commercially on a very limited scale today, but in 2016 production of 40,000-50,000 tonnes per annum will commence at the Port of Rotterdam, from where it easily can be exported to the UK. Another 150,000 tonnes of biopropane are currently produced, but this output is used not as pure biopropane, rather as a mix of bio- propane, methane, butane and naphtha. If economics were attractive, this 150,000 tonnes could be extracted and sold commercially. (UK Dept of Energy & Climate Change et al. 2014)

3.2 Biopropane carbon savings are huge

Under the rules of the Renewable Energy Directive (European Commission 2009), biopropane can be classified as a residue. This allows it to be double-counted in national carbon accounts, and gives it a very low carbon-intensity. As a residue, biopropane's carbon intensity is about 10 CO_2e/MJ (UK Dept of Energy & Climate Change et al. 2014 paragraphs 1.90-1.104). Substituting it for either diesel or petrol would achieve a carbon saving[6] of 89%. This is well above the savings realised by first-generation biofuels, which range from around 16-70%, and is in line with those of second-generation biofuels, which range from about 80-95% (European Commission, 2009, Annex V.A).

3.3 RTFO can incentivise use of biopropane

Recently, the UK Department of Energy & Climate Change (DECC) explored the use of the Renewable Heat Incentive (RHI) to attract biopropane into the British market (UK Dept of Energy & Climate Change et al. 2014). For various reasons, DECC chose not to extend the RHI to biopropane. This has opened the door to the Department of Transport to attract it under the aegis of the Renewable Transport Fuels Obligation.

4 Reduce smog, as a side-effect of the above measures

The presence of smog – a mixture primarily of ozone, particles and nitrogen oxides – is a well-known hazard to health of humans, animals and plants. Road transport is a leading contributor to smog. Cars and vans generate 60% of nitric oxides (NOx) (UK Dept of Environment 2011). Transport is the leading source of carbon monoxide (CO), contributing three-quarters of the UK total[7]. Transport also is the largest single source of volatile organic

[4] An unavoidable adduct of another production process, i.e. the production of HVO biodiesel.
[5] The main constituent of LPG.
[6] As defined in Annex V.C.4 of the Renewable Energy Directive, i.e. (carbon intensity of diesel/petrol minus carbon intensity of LPG)/carbon intensity of diesel/petrol. Carbon intensity is the carbon dioxide equivalent emitted unit of energy used, i.e. in this case CO_2e/MJ. It also could be called a carbon footprint.
[7] http://www.air-quality.org.uk/08.php

compounds[8] (VOCs)[9], accounting for 30% of the total, and it is a major source of particles, generating about one-fourth of all such emissions[10].

A recent study (Atlantic Consulting 2014) compared the emissions of equivalent cars fuelled by petrol, diesel, LPG and CNG. The analysis compared 9,000 models, based on dynamometer trials conducted by independent testers working on behalf of the German Federal Motor Vehicles Agency (Kraftfahrtbundesamt). Compared to diesel and petrol, LPG's performance on key pollutants is:

- NOx – generally, but not always lower than petrol, whilst always substantially lower than diesel, i.e. diesel emissions are several times higher
- Particle matter (PM) – current LPG cars generate no recordable PM emissions. Some petrol cars do, and most diesel cars do, despite the latter having particle filters.
- Hydrocarbon emissions are roughly equivalent between LPG and petrol. Both of these are higher on non-methane-hydrocarbon than diesel.

5 Position LPG and biopropane to complement biomethane in transport

The UK potential for biogas/biomethane is significant: recent studies estimate that it could account to 3.5-7% of Britain's gas consumption in 2050 (UK Dept of Energy & Climate Change et al. 2014). Current production is rising rapidly, although it is still rather insignificant at well under 1%.

The trend for biogas/biomethane development in Europe has been led by Germany, flanked by contributions from other countries, particularly the Netherlands and Scandinavia. In all of these locations, the initial use for most biogas was to generate power and heat for consumption onsite at farms, wastewater treatment plants and other generators of organic wastes. Onsite consumption is cheapest, because it avoids clean-up and transport costs. However, it has two drawbacks: 1) often there is insufficient demand for the heat generated, so it is simply wasted to the atmosphere; and 2) rural power grids are generally unsuited to accepting significant amounts of feed-in electricity.

So the more-recent policy of Germany, and also of the UK, has been to encourage biogas producers to upgrade their product to biomethane, and inject that into the gas grid. Processing and injection adds significant cost, but it does create a fungible fuel that can go most anywhere and is equivalent in performance to natural gas.

Overcoming the financial and infrastructural barriers to biomethane as a transport fuel will take considerable money and time. Infrastructure for this is patchy. Gas-powered vehicles are few, filling stations are almost non-existent, and the cost of transporting gas to them and storing it is significantly higher than that for LPG. Therefore, LPG and biopropane offer a bridge to biomethane, a short-to-medium term step towards greater usage of gaseous fuels.

6 References

Atlantic Consulting. A comparative Environmental Impact Assessment of car-and-van fuels: petrol , diesel , LPG & CNG. 2014 p. 1–62.

European Commission. Renewable Energy Directive. 2009.

[8] Often reported as 'hydrocarbons'
[9] According to APIS, http://www.apis.ac.uk/overview/pollutants/overview_VOCs.htm
[10] http://www.air-quality.org.uk/08.php

European Commission. Methodology for the calculation and reporting of the life cycle greenhouse gas intensity of fuels and energy by fuel suppliers, Annexes 1-4 of the Fuel Quality Directive. 2014.

UK Dept for Transport. UK transport greenhouse gas emissions. 2012 p. 1–18.

UK Dept of Climate Change. Energy Supply. 2013.

UK Dept of Energy & Climate Change. A review of data and methods to calculate greenhouse gas emissions from alternative fuel transport. 2014.

UK Dept of Energy & Climate Change, Atlantic Consulting, Menecon Consulting. RHI Evidence Report : Biopropane for Grid Injection. 2014.

UK Dept of Environment. Air Quality Plans for the achievement of EU air quality limit values for nitrogen dioxide. 2011.