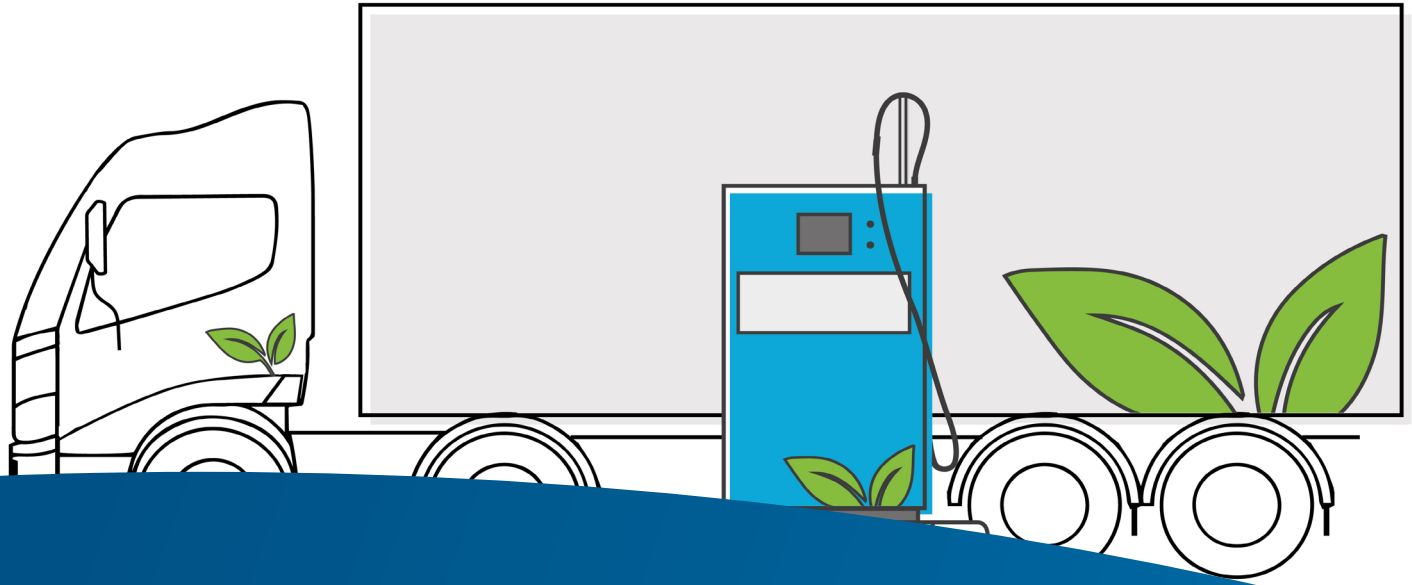
cenex

Lowering your emissions
through innovation in transport
and energy infrastructure



An Introduction to Biofuels for Road Transport

Cenex Insight - July 2021

Biofuels can be a steppping stone for HGVs in the transition to zero emission technologies

Biofuels

Biofuels, also known as renewable, alternative, or low emission fuels, are produced from biological raw materials or feedstock, such as crops or organic waste.

They are generally categorised as 'sustainable' energy sources as the carbon dioxide added to the atmosphere from burning biofuels is absorbed by the organic matter used to produce them. This creates a balanced cycle, whereby the carbon dioxide added to the atmosphere is roughly equal to that taken out.

Currently 4.9% of the total road fuel supplied in the UK comprises biofuels. The most recent government statistics reveal UK biofuel supply achieves an average greenhouse gas (GHG) savings of 76% compared to fossil fuels, and 98% of biofuel feedstocks meet the sustainability criteria via a voluntary sustainability scheme.

For the period 2017-18 biofuels in the UK saved approximately two million tonnes of GHG emissions, equivalent to removing more than one million cars from the road.

It is common for some biofuels to be blended with fossil fuels to lower emissions without impacting performance; low blends of biofuels can generally be used with zero or minor modification to a vehicle, while high blends require a specially modified or compatible vehicle and additional fuel management.

Forecourts in the UK already use biofuels; petrol is blended with 5% bioethanol, known as E5, rising to 10% (E10) in September 2021, while diesel is blended with 7-10% biodiesel (B7- B10). Higher blends are already used as standard in Brazil and America.

The heavy goods vehicle (HGV) sector can use biofuels as a stepping stone to zero emission, as electric and hydrogen technologies are unlikely to be readily available for a few years.

Hydrotreated Vegetable Oil

There are four main types of biofuel currently used for road transport in internal combustion engines, which can be considered conventional biofuel technologies and are most likely used in a fleet. They are Hydrotreated Vegetable Oil (HVO), Biomethane, Bioethanol, and FAME Biodiesel.

Hydrotreated Vegetable Oil

Feedstock: Used Cooking Oil, Animal Fats, Vegetable Oil Pressings → **Conversion:** Hydrotreatment → **Product:** HVO - Renewable Biodiesel

HVO, or renewable diesel, is a hydrocarbon fuel that is chemically similar to standard diesel and as such is considered a direct replacement or 'drop-in fuel'. This means it is fully compatible with, and can be 'dropped into', a fuel supply chain or vehicle without modification (allowing vehicles to operate on diesel if HVO is unavailable). HVO is currently produced by using hydrogen to remove oxygen from waste vegetable oils and fats.

It has no impact on operations, maintenance or vehicle warranty. HVO is not available from public fuel stations and is typically used by commercial fleets in bunkered fuel supplies.

HVO typically costs up to 15% more per litre than diesel or FAME biodiesel and investment costs for HVO production are currently higher with limited suppliers. Despite this, it can be considered a cost effective, low effort method of achieving immediate GHG emissions reductions in otherwise difficult to decarbonise applications.

Biomethane

Biomethane is a gaseous biofuel, consisting mainly of methane, that is used as an alternative to diesel and, in some markets, petrol. It is a sustainable version of natural gas and can be considered as a drop-in fuel replacement for fossil derived natural gas for use in any natural gas vehicles.

Feedstock: Municipal Waste, Food Waste, Animal Manure → **Conversion:** Anaerobic Digestion → **Product:** Biomethane

It is produced by anaerobic digestion (a biochemical process where biomass is broken down by micro-organisms in the absence of oxygen) of organic waste such as food waste and animal manure.

Biomethane can be stored on a vehicle as CNG – Compressed Natural Gas (in pressurised cylinders at 200 to 250 bar) or as LNG – Liquified Natural Gas (which is cooled to -160 C and stored as a liquid at low pressures in cryogenic tanks). LNG offers a greater energy storage capacity (and operating range) for a given tank volume but CNG is considered easier to refuel.

Natural gas vehicles are heavier due to the additional weight of the gas tanks. Many countries have regulations allowing commercial vehicles to operate at increased gross vehicle weights, thereby offering the same payload as diesel vehicles.

Operating range can be optimised by using the correct fuel (CNG or LNG) and gas tank size. Natural gas vehicles require dedicated and economically viable refuelling infrastructure.

Natural gas vehicles are typically more expensive to purchase and maintain than diesel equivalents, however biomethane fuel costs are lower than diesel on a pence per mile basis (particularly with favourable fuel duty).

Bioethanol

Bioethanol is an alcohol fuel produced by the fermentation of sugar and starch crops such as corn, sugarcane and wheat. It can be blended with standard petrol, however it has a lower energy content than petrol (by up to 30%) resulting in higher fuel consumption at higher blends.

Feedstock: Corn, Sugarcane, Wheat → **Conversion:** Fermentation → **Product:** Bioethanol

It is used in a spark ignition (petrol) engine. Ethanol blends up to E10 can be used in modern petrol engines without modification in line with European Union standards, and is typically used as a replacement for petrol in passenger vehicles and some light commercial vehicles.

Higher ethanol blends require modified engines and fuel systems or refuelling infrastructure. Although not available in the UK, flexible fuel vehicles with compatible fuel systems and engines can operate on ethanol blends of up to E85 but are mainly available in Brazil and the United States.

Using E10 instead of E5 in the UK from September could reduce road transport CO2 emissions by 2% annually (750,000 tonnes of CO2), equivalent to taking 350,000 cars off the UK roads.

GHG emissions savings are limited by the so called ‘blend wall’ (e.g. the amount of ethanol that can be blended into petrol without modification), the use of non-waste feedstocks (e.g. food crops) and indirect land use change (the unintended consequences of changing land use for renewable fuel production).

FAME Biodiesel

FAME Biodiesel, or biodiesel, is produced from vegetable oils and animal fats, including waste products such as used cooking oil, blended with standard diesel, with slightly a lower energy content than diesel (~8%).

Feedstock: Used Cooking Oil, Tallow, Vegetable Oils → **Conversion:** Transesterficiation → **Product:** FAME - Biodiesel B7, B20-B100

It is used in compression ignition (diesel) engines, typically in blends up to B7 in the UK, which can be used in modern diesel engines without modification in accordance with European Union standards.

High blend FAME is not available from public fuel stations and is typically used by commercial fleets in bunkered fuel supplies.

Most heavy goods vehicle manufacturers warranty new vehicles for blends of B20 and B30, with some warranting blends of up to B100, however for the highest blends, vehicles are likely to require conversion or modification, including different materials in fuel delivery system to heated fuel lines and insulated fuel tanks for B100.

It also requires more fuel management than regular diesel as it absorbs more water than diesel and can be susceptible to microbial growth, which requires increased fuel filter and oil inspections, and additives to prevent fuel filter blockages.

GHG emissions savings are limited by similar factors as bioethanol. Use of high blends of FAME typically results in a marginal increase in running costs due to increased fuel consumption and increased service / maintenance costs.

Case Study - John Lewis Partnership

John Lewis Partnership's (JLP) has implemented ambitious measures to reduce carbon emissions, with a target of a zero carbon fleet by 2045.

The commercial vehicle fleet consists of 1,600 vans, 400 light trucks, and 600 heavy duty trucks and is reducing road transport carbon emissions by driving fewer miles, improving fuel efficiency, and switching to alternative fuels.

The process of introducing biomethane began with a trial of one demonstration vehicle. JLP rolled the fuel out gradually over the past eight years and now use it in 85 Scania P340 trucks. It has committed to changing the whole fleet of 600 trucks to dedicated gas HGVs fuelled by biomethane by 2028.

The gas trucks cost around 25% more than diesel vehicles to purchase. This is offset by fuel savings, as they are paying around 30-40% less for biomethane on a pence per mile basis. This means they recover the investment in no more than two years.

Over the lifetime of a vehicle the total cost is about 24% lower than an equivalent diesel truck, though payback depends on factors such as fuel price and miles driven.

Vehicles are refuelled with RTFO-approved, and ISCC-certified, methane at the CNG Fuels stations at Leyland and Northampton, UK. The biomethane is produced from waste feedstocks including food waste and manure, and can reduce well-to-wheel GHG emissions by 84% compared to mineral diesel.

Case Study - London Borough of Hackney

At just over 470 vehicles, London Borough of Hackney (LBH) operates one of the largest local authority fleets in London of which approximately 270 are light commercial vehicles supplied by a range of manufacturers. It also operates a fleet of HDVs including Dennis Eagle refuse collection vehicles.

LBH aims for all of its commercial vehicles to be ultra-low emission vehicles by 2028. Ideally this will be achieved by using electric vehicles which have zero tailpipe emissions. However, current vehicle technology does not support this vision, particularly for the heavier vehicles, so LBH is using renewable fuels to minimise its emissions.

LBH used FAME biodiesel in blends of up to 100% for several years, saving significant quantities of CO2. More recently, it has trialled and deployed HVO across its commercial vehicle fleet.

Green Biofuels Ltd supplied HVO produced by RTFO-approved Neste in Finland and the Netherlands. Neste's fuel is produced from waste and residue fat fractions from food, fish and slaughterhouse industries, and from non-food grade vegetable oil fractions. Their HVO supply chain is ISCC certified.

LBH uses an on-site fuel management system to monitor and analyse fuel consumption and mileage data. This means they can calculate their carbon footprint on an individual basis. Analysis undertaken by LBH has found that this fuel offers well-to-wheel CO2 emissions savings of 80% compared to conventional diesel.

The fuel has performed well from an operational point of view. HVO requires no additional maintenance or changes to operational procedure as it is used as a direct replacement for conventional diesel so there is no price differential for the vehicles themselves. The fuel costs more per litre than mineral diesel so there is no whole life cost saving, however it represents a cost-effective option for reducing fleet carbon emissions.

Future of Biofuels

If all the UK's long haul and regional HGV operators converted their fleets to running on high blend biofuel over the next decade, this could save an estimated 13.9 million tonnes of carbon dioxide equivalent. This would be similar to removing a quarter for the UK's car fleet (7.5 million cars).

FAME Biodiesel

At private depots it is expected that over the next 5 years there will be an increase in the number of fleets moving over to B20 and B30 blends of FAME as organisations look to reduce their carbon footprint.

A number of vehicle manufacturers already provide warranty as standard for blends of FAME up to B30 but is expected that the majority of OEMs (original equipment manufacturers) will provide this warranty as standard by 2025.

Between 2025 and 2030 some fleets may begin to move over to B100 fuel blends, potentially requiring them to install specialist equipment.

HVO

Due to the high relative cost of HVO compared to fossil fuel diesel and FAME biodiesel, HVO is expected to remain a niche fuel throughout the next 10 years. It will primarily be used as a drop-in fuel to help fleets meet carbon reduction targets.

Bioethanol

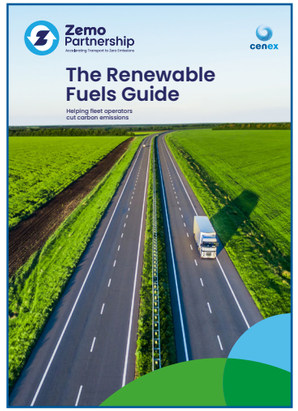
It is likely the UK will maintain E10 for a number of years before preparing for E20 towards the end of the decade.

Biomethane

Biomethane is a fully matured technology and so little development is expected in terms of this technology.

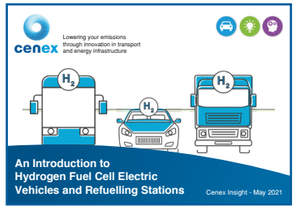
While highly prevalent in Europe, biomethane, and gas refuelling in general, is relatively niche in the UK. As more stations are deployed throughout the UK, a greater number of vehicles will be produced for the UK, specifically enabling long haul fleets to switch to biomethane.

Further Reading



The Renewable Fuels Guide
www.cenex.co.uk/app/uploads/2021/08/ZEMO_Renewable_Fuels_Guide-_2021.pdf

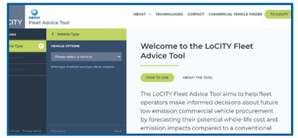
Dedicated to Gas
www.cenex.co.uk/app/uploads/2019/11/324-003-004-Dedicated-to-Gas-Assessing-the-Viability-of-Gas-Vehicles.pdf



An Introduction to Hydrogen Vehicles and Refuelling Stations
www.cenex.co.uk/resources/an-introduction-to-hydrogen-vehicles/

Gas Vehicle Hub
gasvehiclehub.org/

Introduction to Low Emission Road Transport - Future Learn Course
www.futurelearn.com/courses/introduction-to-low-emission-road-transport



Fleet Advice Tool
fleetadvicetool.cenex.co.uk/

See more of Cenex's Projects and Case Studies at www.cenex.co.uk

cenex

Lowering your emissions
through innovation in transport
and energy infrastructure

Cenex

Tel: 01509 642 500
Email: info@cenex.co.uk
Website: www.cenex.co.uk
Twitter: @CenexLCFC
LinkedIn: Cenex