MARCH 2024

# Low carbon fuels guide

This guide covers the main low carbon fuel types that can or may be used by the logistics sector. The guide also covers hydrogen, which can reduce carbon emissions depending on the source and supply chain. It does not cover battery electric options – which are addressed in other Logistics UK briefings.

## Introduction

The logistics sector is embracing the decarbonisation agenda and is committed to playing its part to help the UK achieve net zero. However, whilst industry awaits the development of zero emission technology for long-distance HGVs and rail (on non-electrified lines), and alternative energy sources for ships and aviation, Logistics UK is calling for sustainable low carbon fuels (LCFs) to be incentivised to increase their adoption, given their availability to reduce greenhouse gas (GHG) emissions immediately.

There are multiple alternative fuel types including: biofuels, hydrogen and synthetic fuels, which can all play an important role in decarbonising freight. Some can be blended with conventional fossil fuels and others are for use in their place, and all can provide significant GHG emission savings compared to fossil fuels on a life-cycle basis[1].

There are some policy mechanisms to encourage the uptake of LCFs, including the gas duty differential and the Renewable Transport Fuel Obligation (RTFO).

### We are calling for:

- Greater incentivisation in the tax system to increase their adoption. LCFs must be competitive with diesel and kerosene. Incentivisation should include the development of a Hydrotreated Vegetable Oil (HVO) differential, alongside the existing gas duty differential, decoupling the price of biomethane from wholesale natural gas prices and support from the government for the sustainable production of LCFs including sustainable aviation fuel (SAF).
- A long-term strategy for LCFs across the economy that makes strategic decisions over infrastructure, manufacturing and which fuels would be best used by which industries, given the likelihood of scarcity of supply driven by international demand. This strategy should be evidence-based; keep the cost of logistics down; consider the carbon emissions impact of the whole fuel lifecycle; be backed by investment in infrastructure and R&D; and by a clear regulatory framework.
- A halt to proposed changes to the Greenhouse Gas Protocol (GHGP) that would mean companies would no longer be able to report the benefit of using biomethane in their truck fleets and would have to report as if they were using fossil natural gas which has only a small carbon benefit over diesel.

1 *Low carbon fuels strategy call for ideas, Department for Transport, February 2022*

## Biofuels

Biofuels refer to a series of fuels that act near identically to conventional fossil fuels such as diesel and kerosene. They are still carbon-based fuels but differ from fossil fuels in that they are produced from biomass, which is renewable organic material that comes from plants and animals. It is the production of biofuels that results in their reduced emissions as explained below.

There are two main sources of feedstock for the production of biofuels: food (first generation biofuels) and waste (second generation).

Food: example crops are maize, wheat and sugar which are then converted into a liquid or gaseous form. They are usually blended into fuels such as biodiesel, bioethanol and biomethane and are already available on the market. These are generally cheaper to produce and buy than other biofuels but deliver lower $CO_2$ savings, alongside the additional drawback that they can take up agricultural land. Biofuels from this source are called "first generation biofuels" or "conventional biofuels".

Waste: using waste avoids a food vs fuel scenario. Types of products that can be broken down and used to produce biofuels include straw, grass, woody crops and manure. Biofuels from these sources have greater emissions savings but must undergo a second stage of chemical transition to be used in engines. This results in higher costs and are therefore produced on a lower scale. They are referred to as "second generation biofuels" or "advanced biofuels".

### Biodiesel (first generation biofuel)

Biodiesel is increasingly produced from renewable feedstocks such as brown grease, used cooking oil, soap stock acid oil, sewage system fog, palm oil mill effluent, but has typically been produced from food stocks. There are two main types of biodiesels: biodiesel Fatty Acid Methyl Ester (FAME) and biodiesel Hydrotreated Vegetable Oil (HVO).

**Biodiesel FAME** is most widely available and forms a part of most diesel sold. Various blends of biodiesel are available such as retail diesel, which has a biodiesel blend limit of 7% (B7), B20 (20% biodiesel), B30 (30% biodiesel) and B100 (100% biodiesel).

***Benefits:***

- Several companies produce biodiesel in the UK and supply a variety of high blend biodiesel products.
- Blends of up to B20 can be stored in and dispensed from existing infrastructure for diesel vehicles at no extra costs.

***Disadvantages:***

- Has a lower energy density than diesel and therefore requires more fuel miles per gallon, compared to conventional diesel. This leads to additional costs on fuel.
- Production is relatively simple, but it is problematic at high blends, normally over 20%. It attracts water and hence can suffer from algal growth which causes engine problems. It can also gel in cold temperatures and therefore creates storage issues.
- Most engines are not warranted for high blend FAME.
- There are sustainability concerns about feedstocks, particularly with regards to the destruction of land to grow feedstocks over agricultural products.

**Application:** Low blend drop-in fuel.

**Typical** GHG savings: 85% excluding indirect land use change (ILUC) factors.

**Biodiesel HVO** is a biofuel produced by the hydrocracking or hydrogenation of plant-based or waste oils. It is a more refined product than FAME and because of its greater simplicity through hydrogenation, it has benefits over conventional diesel. HVOs are cleaner to burn and warrant up to 100% blends by most vehicle manufacturers.

***Benefits:***

- A drop-in fuel that can be used at 100% in current vehicle fleets and storage tanks without modifications.
- Cleaner burning than fossil diesel, which can reduce operating costs in urban environments.

***Disadvantages:***

- Significantly more expensive to purchase than conventional diesel.
- Potential challenges over security of supply and cost. HVO uses the same feedstock as the majority of SAF and there are concerns over competition. There is currently no HVO production in the UK.
- The supply chain is less developed than FAME.

**Application:** Drop-in 100% alternative to fossil diesel.

**Typical** GHG savings: 94% excluding ILUC[2].

2 *Low carbon fuels strategy call for ideas, Department for Transport, February 2022*

## Biomethane (first generation biofuel)

Biomethane is created in anaerobic digestion plants where organic material is converted to fuel, digestate (fertiliser) and heat. Biomethane can then be piped into the gas grid, or liquified and transported by road. The fuel has seen strong take up across the freight sector in recent years. However, 44 tonne vehicles fuelled by biomethane have only just become available. It is commonly dispensed as compressed biomethane gas (CBG) or liquid biomethane (LBM)[3].

Primary sustainable feedstocks include food waste and sewage sludge. When untreated, sewage sludge and farm manure result in very harmful fugitive methane emissions, so when the methane is captured and used as a fuel, it has significant carbon reductions. Energy crops such as maize can also be used to make biomethane.

***Benefits:***

- Biomethane produced from wet manure (livestock slurry) can achieve a neutral GHG emission value, generating energy from natural emission sources.
- Cheaper than diesel on a pence per mile basis, partly driven by the reduction in Fuel Duty.
- Refuelling is straightforward and usually takes no longer than filling up a diesel vehicle.

***Disadvantages:***

- Requires purchasing new trucks. Gas HGVs can cost around 25% more than a conventional diesel equivalent when purchased outright[4] and routine maintenance costs are higher.
- Fuelling infrastructure, although growing, is far less developed than diesel fuelling.
- Biomethane still produces the same environmental pollutants as standard methane.

**Application:** Currently best suited to long distance transport by 'return to base' tractors, i.e. supermarket and parcel networks, though use in more typical 44 tonne operations is becoming more attractive.

**Typical** GHG savings: 80% (with and without ILUC)[5].

## Sustainable aviation fuel (SAF) (second generation biofuel)

Sustainable aviation fuel is the main term used by the aviation industry to describe a non-conventional (fossil derived) aviation fuel. It must meet sustainable criteria that considers lifecycle carbon emissions reduction, uses limited fresh water in its production, does not compete with essential food production and causes no deforestation. Government is incentivising uptake with the commitment to introduce a SAF mandate in 2025 requiring at least 10% of jet fuel to be made from sustainable feedstocks by 2030.

Feedstocks can vary, and can include cooking oil, plant oils, municipal waste, waste gases and agricultural residues.

***Benefits:***

- A drop-in fuel, meaning it can be blended into fossil-based aviation fuel and used in existing aircraft and infrastructure without modification.

***Disadvantages:***

- Securing sustainable supplies will be necessary to achieve the intended environmental and net zero outcomes.
- Production and deployment of SAF in the UK is currently very limited.

**Application:** Drop-in aviation fuel.

**Typical lifecycle emissions savings:** over 70%[6].

3 *The Renewable Fuels Guide, Zemo Partnership, July 2023*

4 *Renewable Fuels Guide, Zemo Partnership, July 2023*

5 *Low carbon fuels strategy call for ideas, Department for Transport, February 2022*

6 *Sustainable aviation fuels mandate: Summary of consultation responses and government response, Department for Transport, July 2022*

# Hydrogen

Hydrogen is an emerging fuel for transport. The UK government is currently running trials of hydrogen fuelled vehicles and there are various pockets of funding available to test hydrogen technologies. It is often seen as a potential fuel for road transport and has the potential to be used for vehicles where BEV does not currently provide an effective solution. In addition, hydrogen is expected to have an important role in decarbonising aviation and shipping.

Hydrogen technologies can be separated into two types: hydrogen combustion and hydrogen fuel cell (FCEVs). Both technologies use hydrogen, however, they do so differently. Hydrogen internal combustion engines burn hydrogen, producing power through combustion, in the same way conventional engines operate. Meanwhile, fuel cells use a chemical process to convert hydrogen into electricity.

The high GHG savings for renewable hydrogen are achieved by the fact that hydrogen only emits water when used in a fuel cell and can be made using renewable energy.

While hydrogen does not emit carbon, its production methods can compromise its green credentials. Although hydrogen is an invisible gas, a colour spectrum is often used to describe the carbon footprint of hydrogen, ranging from green (obtained from 100% renewable sources) to black and brown (obtained from coal):

**Green hydrogen** – made by using clean electricity from surplus renewable energy sources, such as solar or wind power, to electrolyse water.

**Blue hydrogen** – produced mainly from natural gas, using a process called steam reforming, which brings together natural gas and heated water in the form of steam. The output is hydrogen, but carbon dioxide is also produced as a by-product. The definition of blue hydrogen includes the use of carbon capture and storage (CCS) to trap and store this carbon.

**Grey hydrogen** - currently, this is the only mass scale and most common form of hydrogen production in the UK. Grey hydrogen is created from natural gas, or methane, using steam methane reformation but without capturing the greenhouse gases made in the process. Grey hydrogen is the same as blue hydrogen, but without the use of carbon capture and storage.

## Hydrogen combustion

In hydrogen combustion trucks, hydrogen is burned in combustion engines, similar to diesel.

***Benefits:***

- Hydrogen is abundant, with technology advancements it could be readily available.
- Offers faster filling times in comparison to charging electric vehicles.
- Lower weight compared to battery electric vehicles (BEV) can increase payload capacity.

***Disadvantages:***

- Challenging to store and transport, and inefficient to use. Hydrogen liquifies at –253$^{C}$, which is expensive and limits mass storage.
- Refuelling infrastructure is very limited.
- Liquid and gaseous hydrogen require partly different infrastructure, which can create competition.
- Hydrogen engines still release nitrogen oxides. Therefore, they require exhaust after-treatments to reduce nitrogen oxide emissions.
- Its business case depends on the ability to use surplus energy close to the point of use, or where other alternatives such as BEV are not available.
- The source of hydrogen has a significant impact on its environmental credentials and availability. Production of green hydrogen is very limited currently.

**Application:** Off-road machinery, low density transport in areas of plentiful renewable electricity. Shipping or aviation.

**Average GHG savings:** 100%, dependent on the hydrogen source and supply chain[7].

7 *Low carbon fuels strategy, call for ideas, Department for Transport, February 2022*

## Hydrogen fuel cell

In FCEVs, hydrogen is converted into electrons and water, with the electrons powering the truck's electric motors.

***Benefits:***

- Offers faster filling times and longer travel distances in comparison to electric vehicles.
- FCEVs are approximately twice as fuel economical as diesel[8].
- FCEV engines produce no emissions other than water vapour.

***Disadvantages:***

- Challenging to store and transport, and inefficient to use.
- Refuelling infrastructure is very limited.
- Fuel cells are expensive to produce.
- Its business case depends on the ability to use surplus energy close to the point of use, or where other alternatives such as BEV are not available.
- The source of hydrogen has a significant impact on its environmental credentials and availability. Production of green hydrogen is very limited currently.
- Overall efficiency of FCEVs is reduced by inefficiencies in the rest of the energy chain.

**Application:** HGVs, refuse vehicles, off-road machinery, low density transport in areas of plentiful renewable electricity. Shipping or aviation.

**Average GHG savings:** 100%, depending on the hydrogen source and supply chain[9].

8 *Hydrogen in a low-carbon economy, Committee on Climate Change, November 2018*

9 *Low carbon fuels strategy, call for ideas, Department for Transport, February 2022*

## Ammonia (hydrogen alternative)

Ammonia is another vector of hydrogen energy, is zero emission at the point of use and is the prime decarbonisation option for maritime. A compound of nitrogen and hydrogen, it takes a liquid form and so requires significantly less storage space than hydrogen, making it potentially more viable. There are different types of ammonia, with a spectrum of "colours" determining sustainability credentials and feasibility. Green ammonia is produced from renewable energy sources using electrolysis, whilst grey ammonia is produced via fossil fuels.

Green and blue hydrogen are potential feedstocks to produce zero carbon ammonia.

***Benefits:***

- It does not emit carbon dioxide during combustion.
- Ammonia has an existing infrastructure for production, storage and global transport.
- It can be stored at relatively low temperatures and pressure.
- Already used at a mass scale in the agricultural industry and a significant level of infrastructure to store and transport it exists.

***Disadvantages:***

- There are safety concerns around ammonia. It is highly toxic and corrosive.
- A high level of alignment is needed at the local and international level to scale the production, bunkering and use as a shipping fuel.
- The type of ammonia has a significant impact on its environmental credentials.

**Application:** Shipping.

**Typical carbon reduction:** Up to 100% depending on the hydrogen source and supply chain[10].

10 *Ammonia as a shipping fuel, Global Maritime Forum, 2021*

# Synthetic fuels

Synthetic fuels are made using carbon captured from the air, waste or biomass, and can be manufactured with similar energy density to conventional fossil fuels.

There are two main types of synthetic fuels: electric fuels (e-fuels), which are made using captured carbon in a reaction with hydrogen, or synthetic biofuels, which are made by the treatment (chemical or thermal) of biomass or biofuel.

## E-fuels

E-fuels are a specific type of synthetic fuels, made using captured carbon and hydrogen, which is made from renewable sources. E-fuels are at very early stages of development and therefore have costly and complicated supply chains.

***Benefits:***

- Compatible with internal combustion engines.
- Can be blended with conventional motor fuels or used as a direct replacement to diesel.
- Existing filling infrastructure can be used to distribute the fuel.

***Disadvantages:***

- Produce as much nitric oxide and other pollutants as petrol or diesel cars[11] and so do nothing to improve air quality.
- Currently expensive to produce.
- Further research is required, however, e-fuels have high energy requirements and need more electricity than BEVs to achieve the same performance.
- Electricity must come from a renewable source.

**Application:** HGVs, shipping and aviation.

11 *Fuelling the future: motive power and connectivity: Government response to the Committee's Third Report, House of Commons Transport Committee, June 2023*

## Synthetic biofuels

Synthetic biofuels are made by the treatment (chemical or thermal) of biomass or biofuel.

***Benefits:***

- Already produced in volume and widely blended with fossil fuels.

***Disadvantages:***

- The scale of synthetic biofuels production is limited due to biomass availability.
- Synthetic biofuels are more expensive than conventional fossil fuels.
- Further research is required to establish exact carbon savings.

**Application:** HGVs, rail and shipping.

Logistics UK is one of the country's largest business groups, representing the entire logistics industry and supporting, shaping and standing up for safe and efficient logistics.

Our membership of over 20,000 includes global, national and regional businesses and SMEs spanning the road, rail, maritime and air industries as well as the buyers of freight services, such as retailers and manufacturers.

As an organisation, we deliver services, representation and thought leadership, helping members and policymakers to seize new opportunities for the sector and the economy as a whole, right across the country.

To discuss this briefing, contact: **policy@logistics.org.uk**

Visit us at: **www.logistics.org.uk**

Follow us at: **@LogisticsUKNews**

T: 01892 526171* F: 01892 534989 www.logistics.org.uk

Logistics UK is a trading name of Freight Transport Association Limited
Registered office: Hermes House, St John's Road, Tunbridge Wells, Kent TN4 9UZ
Registered in England Number 391957