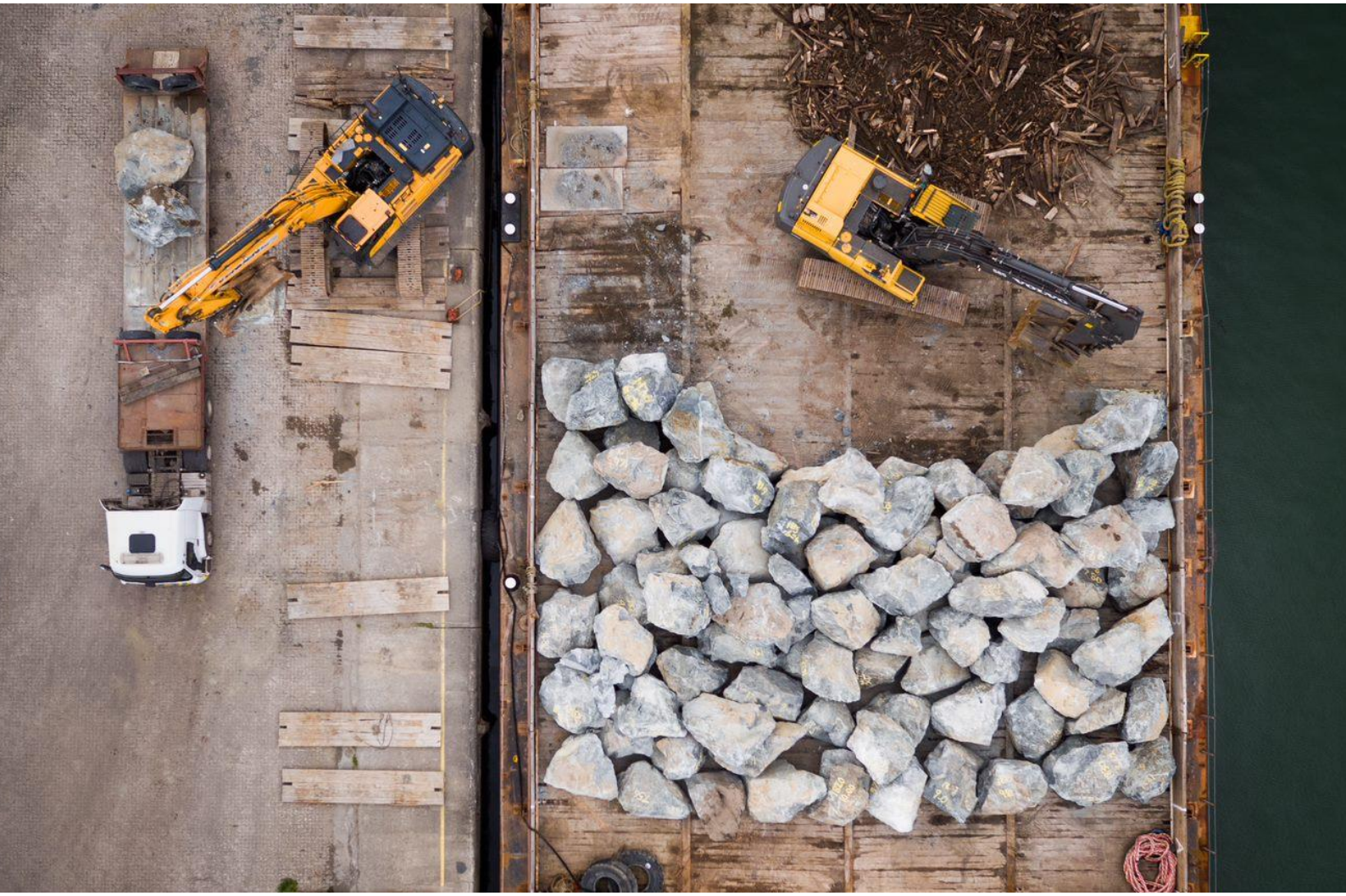
BRITISH PORTS ASSOCIATION



A Guide to Alternative Fuels For Non-Road Mobile Machinery Used in Ports

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Contents

The British Ports Association

The British Ports Association is a national membership body for ports. We represent the interests of operators that handle 86% of all UK port traffic.

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Introduction

This guide provides a high-level overview of a range of low carbon liquid and gaseous fuels that could serve to replace red diesel in non-road mobile machinery (NRMM) deployed in UK ports over the next five years.

These include a variety of biofuels and low carbon hydrogen pathways. For each low carbon fuel information has been presented for six characteristics related to: production method, application in heavy-duty engines, UK market supply chain and deployment, operational considerations, greenhouse gas (GHG) and air pollution emissions compared to diesel and the financial considerations for fuel and equipment costs compared to diesel. A summary is provided of future fuels, these are forecast to come to market at scale from 2030 onwards. Examples of UK initiatives related to certifying sustainable biofuels and retrofit equipment for air pollution control are additional provided.

Biofuels

Policy Landscape

The supply of renewable transport fuels in the UK Renewable Transport Fuel Obligation Order (RTFO) was introduced by the Department of Transport (DfT) over ten years ago to deliver reductions in greenhouse gas emissions from fuels used in road transport and non-road mobile machinery. Currently 5.1% of total road fuel supplied in the UK comprises of biodiesel, bioethanol, biomethanol, hydrotreated vegetable oil and biomethane.

The RTFO requires the renewable fuel supply chains to meet GHG emissions and sustainability standards to be eligible under the scheme, these are –

- Greenhouse gas emission savings of more than 65% compared to fossil fuel. The target is based on lifecycle greenhouse gas emissions. This accounts for growing an energy crop or collecting waste, manufacturing the fuel, transportation, dispensing and combustion.

- Growing crops for biofuel production should not lead to loss of biodiversity or high carbon value land. This ensures protection of sensitive ecosystems such as tropical forests, wetlands and peat land.

Biofuel suppliers can demonstrate their raw materials and supply chain meets these requirements through certification under voluntary sustainability schemes such as the International Sustainability and Carbon Certification (ISCC). These schemes require a chain of custody to be in place with regards to waste feedstocks giving assurance of their origin.

When biofuels undergo combustion, exhaust CO_2 emissions are accepted as zero. This is because CO_2 has already been taken up by plants during their growing process, essentially producing a closed loop in the carbon cycle. Biofuels produced from biogenic waste typically have a much lower carbon intensity than those made from energy crops grown specifically for fuel production. In some cases, the manufacture of biofuels can result in net zero or even negative GHG emissions through avoiding methane released to the atmosphere by certain types of organic wastes.

Biodiesel (FAME)

Production	Biodiesel, as known as FAME (Fatty Acid Methyl Esters) can be produced from a variety of biomass feedstocks including energy crops - soy, rapeseed oil, palm oil and biogenic waste – used cooking oil, fats and greases, tallow oil. Biodiesel is produced via the process of transesterification. Biodiesel can be supplied as 100% renewable fuel, or as a blend with mineral diesel such as B20 and B30.
Application in heavy duty engines	FAME is required to meet specific European fuel specifications. B100 must comply with EN14214 and B20/30 with EN16709. Heavy duty engine manufacturers have different positions regarding biodiesel compatibility and equipment warranty. This should be checked prior to using biodiesel. It is likely that equipment over five years old can run on B20 and B30. Equipment modifications would be required for B100, however there are none currently offered by manufacturers.
UK market - supply chain and deployment	There is an established biodiesel market in the UK, with a high proportion of blend biodiesel used in heavy-duty applications produced from biogenic waste feedstock. Deployment in the NRMM sector is primarily as a renewable fuel for generators.
Operational considerations	Biodiesel requires additional house-keeping compared to conventional diesel. Biodiesel is affected by cold temperatures resulting in the need for heated tanks, fuel lines and dispensing pumps for B100.
GHG emissions	Influenced by the biomass feedstock to produce biodiesel. Biodiesel approved under the RTFO GHG emission savings - 60% (energy crop) to 88% (biogenic waste). GHG emission savings will vary depending on the blend of biodiesel, higher blends giving rise to greater savings.
Air pollution emissions	NOx and PM emission are equivalent to diesel. Plant and equipment will require fitment of exhaust aftertreatment technology to achieve Stage IV and V NRMM emission standards.
Financial	Similar for B20/30, higher for B100 as modification of plant and equipment as well as storage tanks.

Hydrotreated Vegetable Oil

Production	Hydrotreated vegetable oil (HVO) is a paraffinic fuel that is chemically similar to conventional diesel, commonly referred to as a 'drop-in' fuel. HVO can be produced from virgin vegetable oil, typically crude palm oil, and waste feedstocks such as used cooking oil and waste vegetable oils. HVO is produced by hydrotreating vegetable oils and fats. HVO is typically supplied as 100% renewable fuel. HVO can be blended with diesel or GTL (a fossil fuel derived paraffinic fuel).
Application in heavy-duty engines	HVO is required to conform to the European Standard EN15940. The majority of heavy-duty manufacturers approve the use of HVO in their engines.
UK market - supply chain and deployment	Supply chains for HVO are expanding in the UK, with increasing deployment in the NRMM sector. HVO supplied in the UK is produced from biogenic waste feedstocks. Examples of current applications include generators and cranes.
Operational considerations	HVO is classed as a 'drop-in' fuel, which means it can be substituted for conventional diesel with no impact on operational requirements for equipment or fuel storage infrastructure. Existing diesel storage tanks require cleaning prior to storing HVO.
GHG emissions	Influenced by the biomass feedstock to produce biodiesel. RTFO approved HVO GHG emissions savings: 90% to 92% (biogenic waste feedstocks). GHG savings will be lower if HVO is blended with fossil fuel.
Air pollution emissions	Cleaner burning than diesel, producing lower NOx and PM emissions. Plant and equipment will require fitment of exhaust aftertreatment technology to achieve Stage IV and V NRMM emission standards. This will not be achieved using renewable fuel on its own.
Financial	More expensive than diesel, due to the higher price of HVO.

BioPropane

Production	Biopropane, or BioLPG, is a renewable fuel that is chemically identical to conventional fossil fuel LPG. Biopropane is mainly produced as a co-product of the HVO production process. Feedstocks include energy crops and biogenic waste materials.
Application in heavy-duty engines	Biopropane can be used as a direct substitute to LPG and is classed as a 'drop-in' fuel.
UK market - supply chain and deployment	The UK biopropane market is currently small, with applications in the NRMM sector mainly focused on forklift trucks and gas engine generators (mobile and stand-by). Solid oxide fuel cell generators using biopropane have also been trialled in off-road applications.
Operational considerations	Bunkering of biopropane on site. Refuelling can be by a 'Mother and Daughter' system whereby a bulk tank is delivered to the site with systems to enable safe refuelling to smaller, machine-specific storage tanks. This enables the user to purchase at a wholesale LPG cost.
GHG emissions	Influenced by biomass feedstock. RTFO approved biopropane GHG emissions: 66% (energy crop) to 90% (biogenic waste feedstock)
Air pollution emissions	Lower NOx and PM than diesel.
Financial	Investment in new equipment and infrastructure is required if not already using LPG. Fuel duty rate for bio-propane is lower than diesel.

Biomethane

Production	Biomethane is the renewable equivalent of natural gas. Biomethane used in the transport sector is made from a biogenic waste via the process of anaerobic digestion. Waste feed stocks include food waste, sewage sludge, agriculture residues and manure. Biomethane is typically compressed and distributed via the UK natural gas grid.
Application in heavy-duty engines	Biomethane is a 'drop-in' fuel, straight substitution for natural gas.
UK market - supply chain and deployment	Biomethane supply is expanding in the UK, with production focused on biogenic waste feedstocks. In the NRMM sector, biomethane can be used as a renewable fuel in gas powered generators.
Operational considerations	On-site refuelling infrastructure includes compressed biomethane storage tank and dispensing equipment. This can be directly connected to the natural gas grid. In the UK the RTFO enables biomethane is 'mass balanced' with natural gas, fully tracked through the gas grid.
GHG emissions	Influenced by biomass feedstocks, manure as a feedstock can result in biomethane being carbon negative due to the capture and avoidance of methane emissions. RTFO approved biomethane GHG emissions: 75% to 85% (biogenic waste feedstocks)
Air pollution emissions	Lower NOx and PM than diesel.
Financial	Similar to diesel. Require purchase of new biomethane generator, however biomethane has lower fuel duty rate than diesel giving rise to operational cost savings.

Future fuels

Advanced biofuels, such as bio-synthetic diesel and bio-DME are all 'drop-in' fuels and produced from a variety of waste-based biomass feedstocks. Timeline for these renewable fuels coming to the market is currently unclear, likely to be towards the end of 2020.

Low Carbon Hydrogen

Policy Landscape

The UK Hydrogen Strategy was launched in August 2021 outlining the Government's ambitions for expanding the supply and usage of low carbon hydrogen across the UK economy. A key driver for the deployment of hydrogen is to reduce GHG emissions from a variety of sectors including transport. The Government has an ambition to generate 5GW of low carbon hydrogen by 2030 and will be introducing a variety of financial mechanisms to stimulate low carbon hydrogen production. As part of the strategy a low carbon hydrogen standard will be created based on a GHG emission threshold. The RTFO is also supporting the deployment of renewable hydrogen in road transport sector and will be expanding to include the marine sector as well.

Production	Low carbon hydrogen can be produced from various production pathways and energy sources. Over the next five years the predominant pathways will include: - Electrolysis of water using renewable electricity. -Steam methane reformation using natural gas or biomethane with carbon capture and storage (CCS). - Biomass gasification with or without CCS. Once produced, hydrogen is typically stored in high pressure storage tanks and transported to the end users' hydrogen refuelling station as compressed hydrogen. Low carbon hydrogen is likely to be imported into the UK over the next two to three years in liquified storage containers via ship. This will need to arrive at UK ports equipped with dedicated liquid hydrogen storage facilities. Hydrogen can be produced on-site for example via an electrolyser connected to a refuelling station. The electrolyser would need to be powered by renewable electricity for the hydrogen to be to be classed as 'low carbon'. If a direct connection is not possible, renewable electricity could be purchased using power purchase agreement.
Application in heavy-duty engines	Hydrogen can be used to power hydrogen fuel cells (HFC) or an internal combustion engine (H2ICE).

UK market - supply chain and deployment	The low carbon hydrogen market is in its infancy, with very limited commercially available supply chains. This situation will change over the next few years with production expanding. Large scale commercialisation is likely to materialise from 2030 onwards. The use of hydrogen in the NRMM sector is currently in the early stages, with H2ICE and HFC, pilot and demonstrator applications including forklift trucks, excavators, dump trucks, mixer truck and generators. Several ports are looking at the opportunities for producing, supplying, and using hydrogen including Immingham, Shoreham and the Orkney Islands in the UK. Some feasibility studies include the evaluation of the potential for hydrogen fuelled port cargo handling machinery.
Operational considerations	The storage, and use of hydrogen, requires stringent health and safety procedures and measures. The volume of hydrogen stored at a location will influence specific health and safety regulations that need to be adhered to.
GHG emissions	Influenced by the production pathway and energy source, plus downstream supply chain in particular method of storage and transportation. Production routes involving renewable energy (green hydrogen) result in the lowest GHG emissions. When hydrogen is produced using biomass feedstocks, and linked with CCS, GHG emissions can be negative. GHG emissions range: -30% (biomass gasification with CCS) to 98% (on-site electrolyser powered by wind turbines) Hydrogen produced by electrolysis powered by UK grid electricity today has a higher carbon footprint than diesel.
Air pollution emissions	HFC produce no emissions to air, H2ICE emit NOx emissions, lower than diesel.
Financial	Significantly higher - purchase of new HFC/H2ICE equipment, hydrogen storage and refuelling infrastructure and cost of fuel. Economic viability depends on vehicle fleet size, shift duration, location, availability of hydrogen, infrastructure requirements and availability of subsidies or financial incentives.

Future Fuels

Low carbon methanol, ammonia and electro-fuels (synthetic diesel) are identified as future 'hydrogen' fuels, however these are unlikely to be commercialised in UK market until after 2030. Specific engine technology is required for these fuels; these are in demonstration phase.

Initiatives supporting clean & sustainable low carbon fuels adoption

Zemo Renewable Fuels Assurance Scheme

The Renewable Fuels Assurance Scheme (RFAS) is an independent initiative managed by Zemo Partnership. The Scheme verifies claims made by companies supplying renewable fuels to heavy-duty vehicle and equipment operators regarding their product's GHG emission savings performance and provenance of raw material feedstocks. The RFAS encompasses the complete renewable fuel supply chain from feedstock cultivation or waste raw material collection, production and distribution of the final product to the customer.

The RFAS works alongside the Government's RTFO providing a mechanism for guaranteeing that fleet operators are purchasing bulk supplies of sustainable low carbon fuels. Transport sectors covered by the scheme are road vehicle and heavy duty off-highway, notably non-road mobile machinery used on construction sites and ports. Example renewable fuel types that can be approved include biodiesel, hydrotreated vegetable oil, biomethane, renewable hydrogen, various development fuels and blends of renewable fuels. To date ten renewable fuel suppliers are approved under the Renewable Fuels Assurance Scheme.

Further information - Renewable Fuels Assurance Scheme | Fuels | Zemo Partnership

NRMM Retrofit Accreditation Scheme

The Energy Saving Trust independently certifies NRMM NOx and PM emission reduction systems that can be retrofitted to NRMM. This allows them to be used in areas which experience air quality challenges. Gaining NRMM certification offers the assurance that retrofit equipment meets the requirements of local authority air quality policy or the environmental requirements of certain development projects. The latest exhaust emission standards NRMM powered by diesel and gas engines are Stage V limits. Examples NRMM with retrofit technology certification includes excavators, bulldozers, generators, forklifts, mobile cranes. At present this is for equipment predominantly used on construction sites.

Further information regarding approved technologies - Non-road mobile machinery certification - Energy Saving Trust