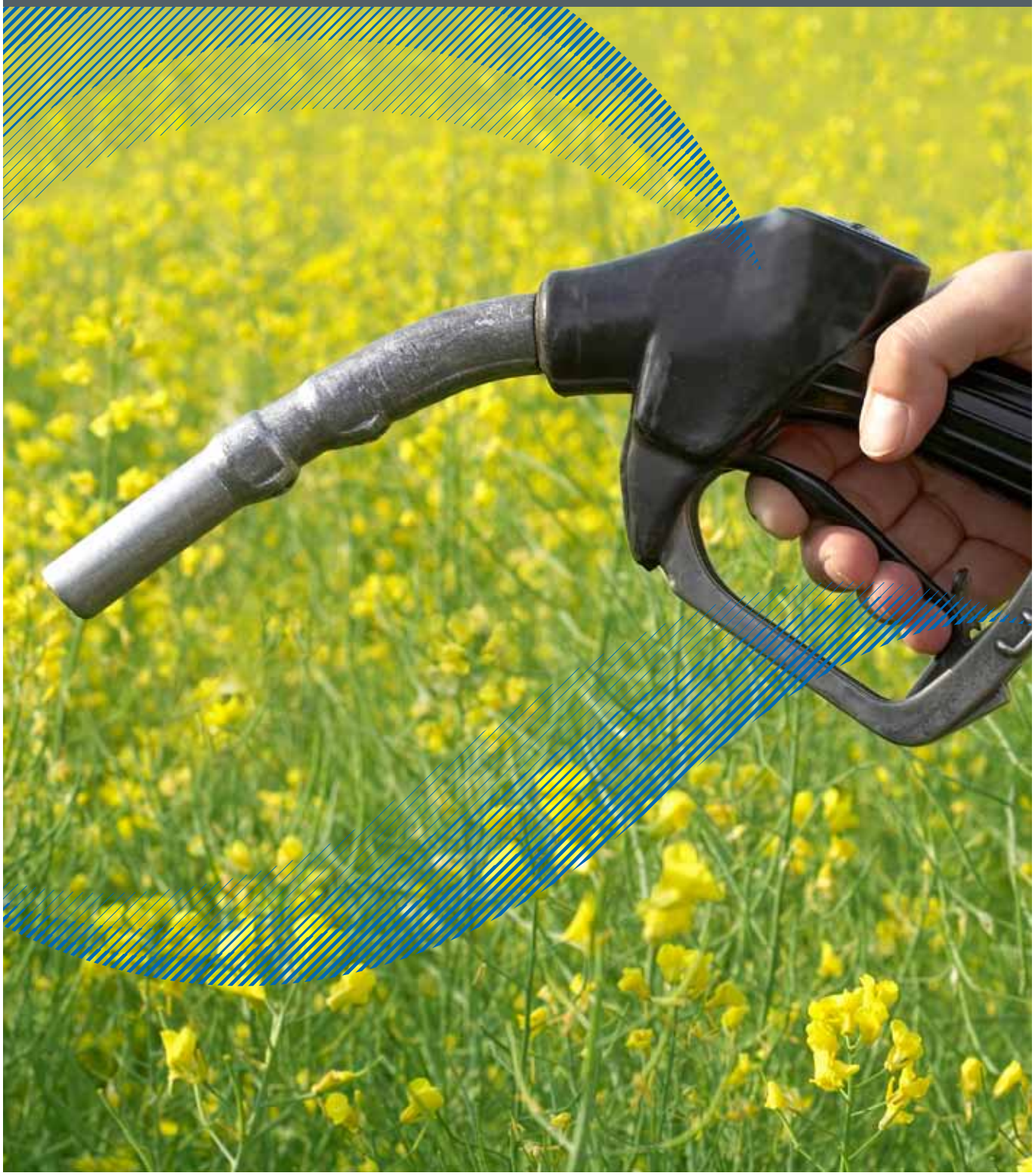
SUSTAINABLE ENERGY AUTHORITY OF IRELAND

A Guide to

Alternative Fuels for Commercial Vehicles

Diesel fuel is increasing in price due to increasing world demand: this guide helps commercial fleet managers plan for alternative commercial transport fuels.



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OVERVIEW

Diesel is the most common fuel used by commercial vehicles and fleets. Diesel engines are up to 50% more energy efficient than petrol engines. This is an initial guide to the alternative fuel types. Government legislation may require 4% bio fuels in both petrol and diesel. Generally speaking these fuels are sourced from plants or waste products and are known as alternative or bio-fuels.

For electric and hybrid vehicle guidance see SEAI's specialist guides on these vehicles.

Before switching some or all of the vehicle fleet to alternative fuels consider these points:

- **Replacing fossil fuels** with bio fuels in an existing fleet reduces **CO_2 emissions**, as the fleet uses less fossil fuel. Bio fuels balance their CO_2 emissions with the CO_2 absorbed whilst growing.
- **Improving fuel efficiency** by 10% on say 50,000 litres per year cuts costs by around €5,000 or more (depending on price), whilst reducing emissions by 10%.
- **Duty cycle;** using bio-fuel in urban (stop-start) traffic is inefficient compared to electric vehicles.
- **Supply;** are the quantities required available? Where and when needed, and at the right price?
- **Producing bio-fuel on-site** requires adequate supplies of feedstock and a bonded warehouse must be set up in consultation with Customs and Excise. Unless you are licensed for Mineral Oil Tax Relief, excise duty must be paid for road use.

SOME VEHICLES CAN ALREADY USE ALTERNATIVE TYPES OF FUEL

- All diesel engines can run on a 7% biodiesel in diesel mix (B7 is in the EN590 diesel standard)[1]
- From July 2010, transport fuels may contain 4% bio fuel (complying with EN standards)
- Some new diesels can run on 30% biodiesel in diesel mix (B30) or even 100% biodiesel (B100)

WATCHPOINTS

- **Consult the vehicle manual/warranty documents** or alternatively the main dealer, to verify what biodiesel blends above B7 (>7% biodiesel) the vehicle can run on, if any, without invalidating its warranty.

For more information refer to SEAI's other Transport Energy Guides, visit **www.seai.ie/transport**

PURE PLANT OIL – PPO

(German Quality Standard DIN 51605) NOT A BIO DIESEL

Also known as SVO – Straight Vegetable Oil

- Commonly made from Oil Seed Rape, pressed and filtered to produce oil and animal feed.
- Benefits the environment with reduced CO_2 emissions and uses no heat or chemicals in its production.
- Needs vehicle conversion, can solidify at low temperatures and may need diesel to start: Most conversion kits are two tanks, so vehicle can still run on diesel, but majority of time is on PPO, reducing emissions.
- For long term durability it is often necessary to increase the oil change frequency and to pay attention to engine maintenance.

Suitable where security of supply and price are important: Can be grown, pressed and used locally in Ireland. PPO is supplied by specialist fuel companies around Ireland.

BIO DIESEL

(Quality Standard EN14124)

- A product of the transesterification of vegetable/waste oil or animal fats.
- Benefits the environment by using up waste, for example used cooking oil (UCO).
- **But** needs a chemical process and energy for production.
- Can "splash mix" biodiesel with fossil diesel on site, ensure it is to EN14124 and don't exceed 7% biodiesel, if the vehicle warranty restricts fuel to B7.
- For B30 and B100 the vehicle may not require conversion, but check the vehicle manual and warranty to understand if and in what percentage bio-diesel may be used.

Suitable where there is a sustainable supply of feed stock: Bio-diesel is supplied by specialist fuel companies around Ireland.

1 *The Fuel Quality Directive (2009/30/EC of 23 April 2009), or FQD Directive: Standards - Current European CEN Fuel Specifications for pure bio-components:*
· *For gasoline: 5% v/v (E5) ethanol and 2.7% oxygen (EN228)*
· *For diesel: 7% v/v (B7) FAME in diesel fuel (EN590)*
http://ies.jrc.ec.europa.eu/jec-research-collaboration/regulatory-framework.html

BIO ETHANOL

(Ethanol Standard: EN15376)

Although manufacturers can modify diesel engines to run on 100% ethanol (E100), bio-ethanol is mainly used in petrol engines to deliver higher performance and reduced emissions.

- Used as an additive to petrol to make E5 (5% ethanol in petrol mix) for any car.
- E85 (85% ethanol in petrol mix) can only be used in specially designed "Flexi Fuel" engines.
- In Ireland E85 is made from Irish produced milk whey, a waste from food production. As the cows feed mainly on grass the saving in CO_2 emissions is up to 70%.
- Bio-ethanol has an energy content of 5.885 kWh / L (vs. petrol at 9.347 kWh / L), but a higher octane number, allowing modified engines to run at higher compression ratios and thermal efficiency.

Availability – E5 is supplied as regular petrol in fuel stations, while E85 is sold in certain stations with dedicated pumps. A bio-ethanol fuelled vehicle will use more litres of fuel compared to petrol, due to reduced energy content, bio-ethanol is priced lower to reflect this extra usage.

GAS

Gas as fuel is usually either Liquefied Petroleum Gas (LPG) or Compressed Natural Gas (CNG).

Almost eliminates emissions of soot particles (PM) and Nitrous Oxide (NOx) in urban areas[2].

Gas can be 25-60% less expensive than diesel, leading to substantial cost savings.

Natural gas is mainly methane (CH_4), which has a boiling point of -259°F (-160°C). As a result, the fuel stored in a vehicle at room temperature is in a gaseous state. To transport the fuel, it is either liquefied and stored at very cold temperatures (LNG), or it is compressed into tanks so that it does not take up as much physical space in the vehicle (CNG).

CNG provides a pathway to renewable fuels through the use of bio-fuels. CNG engine technology also allows the use of up to 60% hydrogen blended with 80% methane, suggesting a bridge to the use of hydrogen in transport. Refuelling can be as fast as 5 minutes, suitable where cost and air quality are important. Available widely through the Bord Gais network

TYPES OF GAS VEHICLE

Dedicated CNG vehicles – Vehicles that only use CNG

Dedicated LNG vehicles – Vehicles that only use LNG

Bi (or multi)-fuel vehicles – Vehicles that run on both CNG/LNG and petrol or other fuels

Dual-fuel vehicles – Vehicles that burn two fuels at the same time; typically diesel to ignite and then runs on CNG

NGVs (Natural Gas Vehicle) require a spark plug to ignite the gas in the chamber. Consequently, NGVs are not typically bi-fuel with diesel (diesel engines use pressure for ignition instead of spark plugs). The dual-fuel engines do not usually have spark plugs. Instead, they use the diesel in the piston cylinder to ignite the larger amount of natural gas that then provides the power for the engine. This combination helps to greatly reduce diesel usage and emissions output.

Image courtesy of Volkswagon

2 EPA USA

BIO GAS

- Biogas produced by the decomposition of organic waste; in landfill sites it is typically composed of 60% methane and 40% carbon dioxide.
- Biogas can also be produced in anaerobic digesters from organic waste or waste water treatment plants.
- In either case the biogas can be upgraded to transport fuel quality, similar to natural gas, but with 70-86% less carbon emissions than for natural gas .
- Vehicles are available direct from manufacturer and dealers. Any engines using these gases must have a conversion kit fitted by a certified supplier, or supplied by the manufacturer via the dealer.
- Although other new gases and ethers are becoming available for use as transport fuels, significant investment in vehicles and infrastructure is needed before they will become widely available.

Emissions savings in CO_2 compared to diesel	
Biogas from municipal organic waste as compressed natural gas	80 – 73%
Biogas from wet manure as compressed natural gas	84 – 81%
Biogas from dry manure as compressed natural gas	86 – 82%

NEXT GENERATION BIO FUELS

Although roughly 30% of Irish bio-fuels are grown in Ireland, there is an ongoing debate internationally regarding food versus fuel and biodiversity issues. For this reason, both the EU and the USA are supporting the development of 'second-generation' bio fuels[3].

ADVANTAGES OF SECOND-GENERATION BIO FUELS

(From http://www.euractiv.com/en/energy/biofuels-generation/article-165951):

- **May have a more favourable GHG (Green House Gas) balance.**
  - Cellulose ethanol could reduce CO_2 by 80% compared to petrol, whereas corn or sugar-beet ethanol reduces CO_2 levels by typically 61%.
  - As for diesel, Biomass-to-Liquid (BtL) technology could reduce CO_2 emissions by up to 95%, as opposed to typically 45% for currently-available biodiesel from oil seed rape.
- **Produced from a wider range of biomass feed stocks** not competing with food production.
- **Use less land** compared to current bio fuels, as plant science may enhance production volume.
- **May ultimately be produced at cost-competitive prices.**

CHALLENGES

- **Cost:** Relatively high production costs (currently higher than fossil fuels) mean that second-generation bio fuels cannot yet be produced commercially
- **Technological breakthroughs:** Key developments are needed on enzymes, pre-treatment and fermentation in order to make processes more cost and energy-efficient.
- **Infrastructure needs:** The commercialisation of second-generation bio fuels necessitates the development of infrastructure for harvesting, transporting, storing and refining biomass.

All of which will take time.

3 The Renewable Energy Directive (2009/28/EC of 23 April 2009), or RED Directive, poses requirements for bio-fuels in the transport sector. EU Member States are required to meet 10% renewable energy share in the transport sector by 2020.

Bio-fuels sustainability is required for feedstock and bio-fuels production as well as minimum greenhouse gas (GHG) savings per energy unit. http://ies.jrc.ec.europa.eu/jec-research-collaboration/regulatory-framework.html

ALTERNATIVE FUEL CHECKLIST

With many factors to be considered, this short checklist may help in reaching a decision.

Vehicle fleet questions	Short-term	Long-term
Are current vehicles in the fleet suitable?	Y / N	
What is the life for new vehicles i.e. beyond normal 3 year cycle		
Cost of conversion / additional capital cost	€	€
Location– where is fuel available?		
In fleet operating area	Y / N	Y / N
Nationally or internationally	Y / N	Y / N
Additional cost of installing on–site tank and pumps	€	€
Cost effectiveness		
How much is price per litre higher or lower than diesel?	€	€
Can you fix price in advance to improve cost certainty?	Y / N	Y / N
How efficient is alternative fuel in L/100Km (or MPG)?	%	%
How much extra fuel will be used compared to diesel?	%	%

DIESEL ALTERNATIVES COMPARED

Use these facts and figures to help guide decision making.

Aspect	PPO	Bio diesel	Diesel (DERV / EN590)
Raw material /source	**Oil Seed Rape (typically grown in Ireland)**	**Oil Seed Rape, Wastes (multiple sources)**	**Crude oil distillates**
Manufacturing process	Pressing	Transesterification	Refinery
Cetane number (measure of combustion quality, higher is better)	39	Vegetable oil: 46 to 52 Animal-fat: 56 to 60	51 (Premium diesel = 60)
Carbon Reduction (compared to diesel)	58%	45%	0
By-products	Animal feed, straw	Glycerine	None
Energy content	9.445 kWh / L	9.167 kWh / L	10.161kWh / L
Price (Use spaces to compare)	€	€	€

ACCELERATED CAPITAL ALLOWANCES (ACA) TAX INCENTIVE

SEAI operates the ACA scheme which allows the full value of the Corporation Tax relief on capital assets to be claimed in year 1 rather than over the standard 8 year depreciation period. This incentive is only available for specific technologies which include electric vehicles and their associated charging equipment. More details on the ACA and its associated products are available from www.seai.ie/aca

Sources: *kWh per unit of fuel from SEAI EPSSU. CO_2 emissions per unit of fuel from Renewable Energy Directive (2009/28/EC) – Annex III OF THE EUROPEAN PARLIAMENT of 23rd April 2009.*

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Ireland's EU Structural Funds Programmes 2007 - 2013
Co-funded by the Irish Government and the European Union
The Sustainable Energy Authority of Ireland is financed by Ireland's EU Structural Funds Programme co-funded by the Irish Government and the European Union.