VOLVO

Alternative fuels for trucks – the ultimate guide

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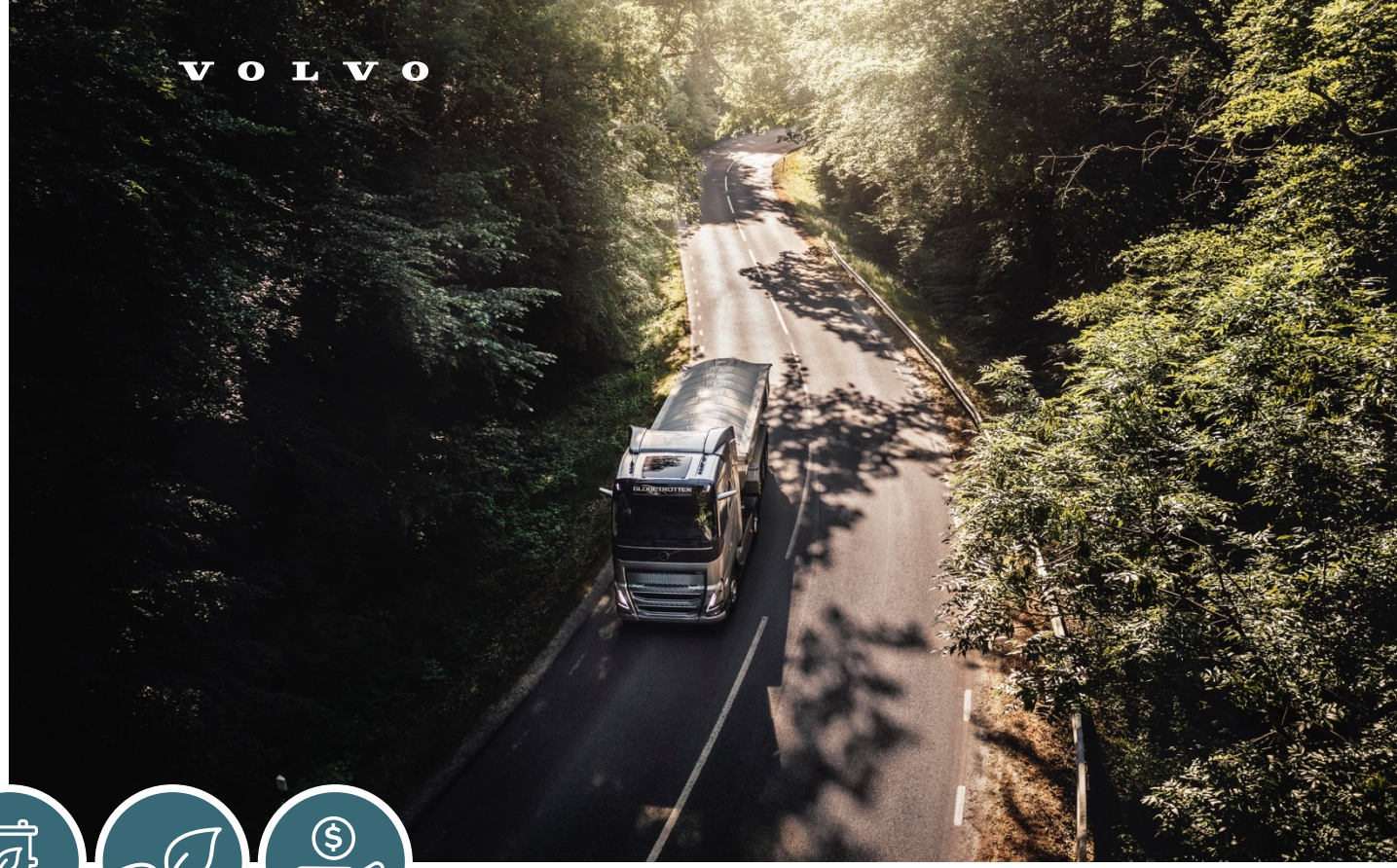
Why we need alternative fuels

While diesel is still the most widely used fuel in the trucking industry, it is under increasing pressure from legislation on CO_2 emissions, changing consumer preferences and the growing viability of alternative fuels. It's clear that change is on its way.

For instance, Bloomberg predicts that by 2040, electric vehicles will account for almost 70% of light commercial vehicles sales globally, and 32% of medium and heavy-duty commercial sales by 2050. Other alternative fuels are also increasing, like LNG (liquefied natural gas), which is projected to grow significantly between now and 2030. Meanwhile hydrogen production and fuel cell technology continue to attract large-scale investment and their uptake is predicted to increase rapidly in the coming years. By 2035, as many as 850,000 medium- and heavy-duty trucks could be powered by hydrogen in Europe alone.

Which is the best fuel for trucks?
In this guide, we take a look at some of the main advantages and disadvantages of the different alternative fuels. We also outline some of the key considerations to take into account when adding a vehicle with an alternative driveline to your fleet.

Hydrotreated vegetable oil (HVO) – what is it?



HVO is essentially a second-generation biofuel that can be produced from a wider range of materials. The production process involves adding hydrogen to vegetable oil to create a fuel that is very similar to conventional diesel. Production of HVO reached 9 million tonnes in 2022.

Advantages

- In terms of performance, HVO is virtually the same as diesel.
- It can be produced from a broad range of raw materials including low-quality waste products that cannot be used in biodiesel.
- It can be better for the environment than biodiesel depending on the materials used in its production. For example, with bio-oils, its well-to-wheel carbon emissions can be even lower.
- It can be used in vehicles as a direct replacement for diesel. No modifications are needed.
- It is free of biodiesel's technical limitations – such as solidifying in cold weather or producing harmful organisms in the fuel tank.
- Diesel refineries can be converted to HVO production as demand for fossil fuels decreases.

Disadvantages

- Even with a broader range of raw materials that can be used in production, resources are still limited.
- If produced from palm oil or waste from palm oil production, HVO could contribute to deforestation and high carbon emissions.
- While carbon emissions are low, emissions of NOx and particulates are not reduced.
- At this stage, HVO is more expensive than diesel in most markets.

Electrofuel – what is it?

Electrofuels are a class of fuel produced by electrolyzing water to create chemical building blocks, which are added to CO_2 to create a diesel-like fuel with many of the same properties. The field is still in its infancy. If, however, a source of cheap, renewable electricity can be secured, then production of carbon neutral fuel would be almost limitless.

Advantages

- The key raw material – water – is plentiful.
- If the electricity used is from a renewable source, then the resulting fuel will be carbon neutral.
- It can be used in vehicles as a direct replacement for diesel.

Disadvantages

- For minimal climate impact, the electricity needs to come from a renewable source.
- Without access to cheap electricity, the production process is likely to be expensive.
- Emissions of NOx and particulates are not reduced, thus electrofuels do nothing to improve air quality.

Biodiesel – what is it?

Biodiesel, also known as Fatty Acid Methyl Ester (FAME), is a renewable fuel made mainly from vegetable oils. The type of raw material affects the CO_2 reduction achieved, which is between a 30% and 70% reduction, compared to regular diesel.

A fuel consisting of 100% biodiesel is called biodiesel B100. In addition, there are also blends and different levels, for example B7, B20 and B30. The Euro 6 emission legislation requires a separate certification for biodiesel as it does not completely fulfil the diesel fuel standard EN590.

Advantages

- Biodiesel is a non-fossil fuel with climate benefits.
- The cost of biodiesel is in some countries lower than for standard diesel.
- Can be used in a diesel engine (with engine adaptations).
- Biodiesel can be mixed with conventional diesel, reducing the climate impact.

Disadvantages

- Biodiesel has challenges to meet EU CO_2 performance requirements on biofuels as only a few raw materials fulfill the demands.
- 100% biodiesel has an 8% lower energy content.
- Higher vehicle maintenance needed.
- Some sources of biodiesel, palm oil is one example, can be used both in fuel and food production. This might harm the food supply and is often called the food versus fuel dilemma and can make biodiesel less preferable, as it competes with food production.

Synthetic diesel – what is it?

Synthetic diesel is produced from gas, which converts a mixture of hydrogen and carbon monoxide into a diesel-like liquid fuel – a process also known as Fischer-Tropsch. The knowledge and technology that enables this has been around since the 1920s however the production process has been too expensive to make it commercially viable. In a study conducted by Bosch, it was estimated that if renewable and synthetic fuels were widely used by European passenger cars by 2050, this would save around 2.8 gigatons of CO_2 being released into the atmosphere.

Advantages

- If the gas used comes from a renewable source, then it will result in low carbon emissions well-to-wheel.
- It can be used as a direct substitute for diesel, and no modifications to the vehicle are needed.
- Likewise with infrastructure. The same equipment for refilling, storage and transportation used for diesel can be used for synthetic diesel.

Disadvantages

- Synthetic diesel is expensive to produce and energy intensive. To be commercially viable, typically gas prices need to be low and oil prices high.
- To date, it has only been produced in small quantities.
- The well-to-wheel emissions depend on the gas used to produce the synthetic diesel, and currently the two main sources are fossil fuels: gas and coal.
- Synthetic diesel still emits NOx and particulates.

Electric vehicles – what are they?

Electric vehicles typically come in the shape of hybrid electric (HEV), plugin electric (PHEV) and battery electric (BEV). Lithium ion batteries are a key component in such vehicles, with their size, cost and capacity often determining their viability.

Advantages

- Zero tailpipe emissions of CO_2, particles and NOx.
- If the electricity used is produced from a renewable source, the well-to-wheel CO_2 emissions are virtually zero.
- Electric drivelines make less noise than a combustion engine.
- Less service and maintenance is required since an electric vehicle has fewer moving parts.

Disadvantages

- Electric vehicles cost more than their diesel-powered equivalents.
- The infrastructure required for charging is still under development.
- The batteries add weight to the truck and may result in lost payload.
- The current range of an electric vehicle is typically up to 300 km when fully charged – well short of what is required for long-haul applications.
- The production of the batteries has a significant environmental impact. But usually a life-cycle assessment will show that the breakeven will be reached within a year. If you are interested in learning more about electric truck batteries, click here.

Hydrogen – what is it?

Hydrogen is a zero-carbon fuel that works with two different technologies. It can be used as a direct substitute for diesel in a hydrogen internal combustion engine (H2ICE). Or it can be used in a fuel cell, where hydrogen is combined with oxygen with the resulting chemical reaction generating electricity. It is a clean process with the only byproducts – apart from electricity – being warm air and water vapor. Check out this link if you are interested in learning more about hydrogen as an alternative fuel source.

Advantages

- Hydrogen is one of the most abundant resources on earth.
- When used in a fuel cell, electricity is produced without any tailpipe CO_2 or NOx emissions and with low noise levels.
- When used in a combustion engine there are no tailpipe CO_2 emissions from the combustion of hydrogen.
- Compared to lithium-ion batteries, hydrogen fuel cells can deliver longer ranges. They can also be used as range extenders in conjunction with batteries.
- Low well-to-wheel emissions if the hydrogen is produced from a renewable source.
- Hydrogen can offer the same benefits as electromobility – namely low emissions and noise – without being a drain on a country's power grid.

Disadvantages

- Unfortunately, at this stage around 95% of the world's hydrogen is produced from fossil sources, namely natural gas and coal.
- Fuel cells are expensive to produce and hydrogen is 3-4 times more expensive than diesel.
- The infrastructure is lacking and is expensive to build.

Compressed Natural Gas (CNG) – what is it?

CNG (Compressed Natural Gas) is a fossil fuel. It has methane as the main component and is typically compressed to 200-250 bar. CNG has lower energy density than LNG so it is more suited to urban and regional applications. Most CNG engines use the spark ignition or Otto cycle, which reduces energy efficiency and drivability, compared to the diesel cycle.

Advantages

- Lower tailpipe (TTW) CO_2 emissions than diesel, typically -10% for spark ignited engines.
- Natural gas is widely available.
- There is an existing fairly distributed filling station network for CNG.

Disadvantages

- Natural gas is a fossil fuel.
- Lower energy density compared to LNG.
- High fuel price fluctuations.

Liquefied natural gas (LNG) – what is it?

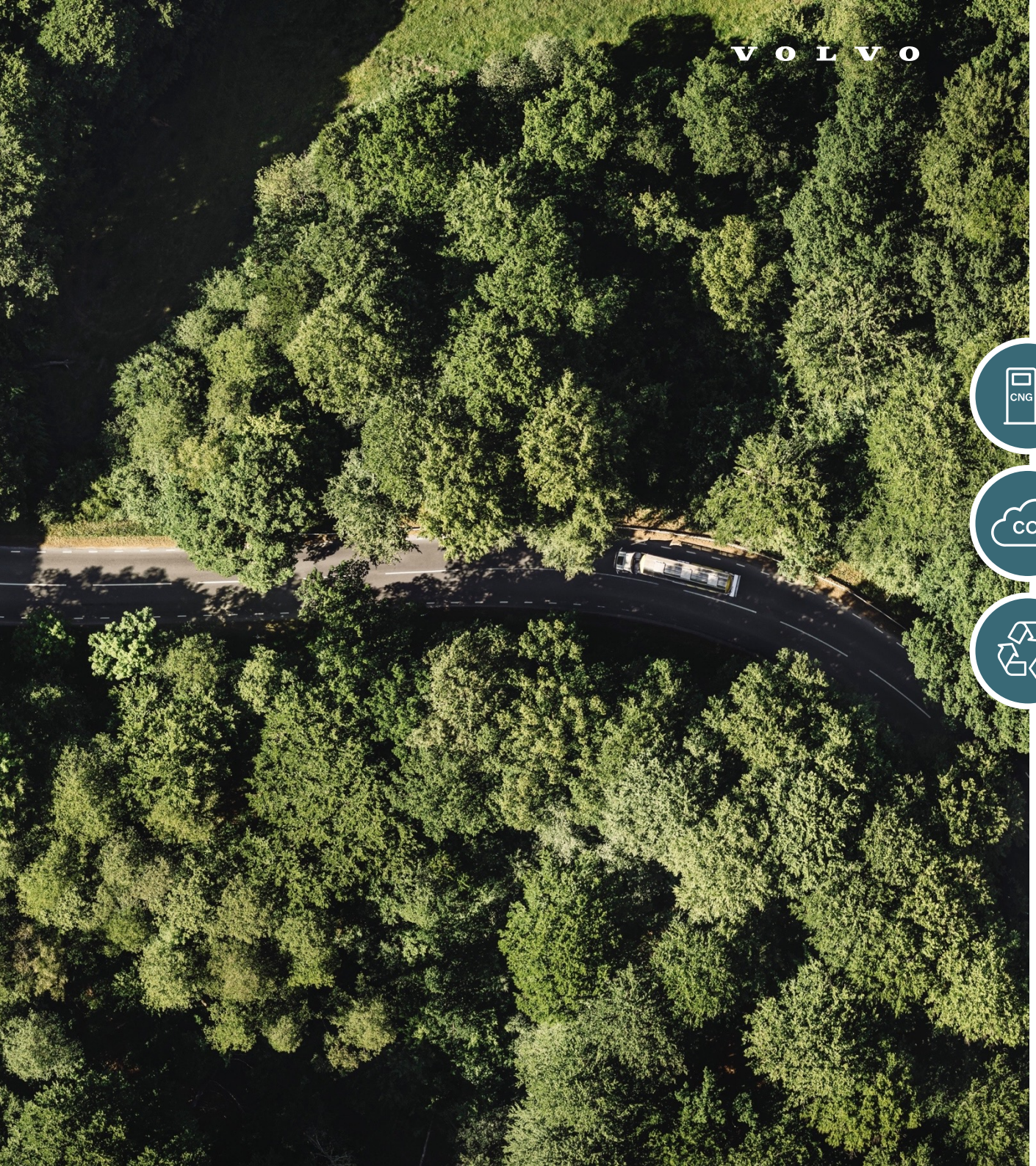
Liquefied natural gas is natural gas that has been cooled down to liquid for shipping and storage. While natural gas is a fossil fuel, Liquefied Natural Gas (LNG) can provide between 10-20% less CO_2 emissions compared to diesel. Global demand for LNG is expected to grow by 3.6% per year up until 2035. Currently there are around 700 LNG refilling stations in Europe, which is increasing rapidly.

Advantages

- Lower tailpipe CO_2 emissions than diesel. The exact reduction can vary depending on location but it is approximately 10% lower in spark ignited engines and up to 20% lower in compressed ignited engines.
- Natural gas is widely available and cheaper than diesel.
- Currently LNG-powered trucks can travel up to 1,000 km before refilling, making it a viable fuel for long-haul applications.
- The LNG refilling network in Europe is growing rapidly.

Disadvantages

- Natural gas is a fossil fuel.
- While it is growing rapidly, the infrastructure and refilling network is still limited and will require continued investment.
- The infrastructure required for production of LNG is expensive and can be energy intensive.
- For a vehicle to use LNG, additional tanks are needed, which will incur an extra cost as well as decrease the truck's payload by adding extra weight.



Bio-CNG – what is it?

Bio-CNG is produced from biomass and waste, such as food waste. The biomass is processed into gas, which is then cleaned, to leave the final product of methane and a small amount of CO_2. This gas is then compressed and stored.

Advantages

- Biogas has very low CO_2 emissions since the production is based on biomass or waste. Between 70% and 100% reduction compared to regular diesel.
- Biogas is available in several countries. There is a large potential for more biogas production.

Disadvantages

- Lower energy density compared to Bio-LNG.
- Higher production cost than CNG.

Bio-LNG – what is it?

Bio-LNG, otherwise known as liquefied bio methane (LMB) has the same chemical formula as LNG. It is produced through a process where biogas from organic waste such as animal manure, sludge and waste is converted to high-quality bio methane and liquefied to -162 degrees Celsius.

Advantages

- Compared to LNG, Bio-LNG emits less CO_2. It also has higher fuel potential (the ability to replace diesel) than other alternatives like biodiesel.
- Raw material is plentiful and as it is derived from waste or agricultural biomass, Bio-LNG can be produced locally saving transport costs and carbon emissions.
- Like LNG, Bio-LNG has a high energy density and is therefore suitable for long-haul transport.
- Bio-LNG could operate on existing LNG infrastructure.

Disadvantages

- Bio-LNG is still an evolving technology with limited production infrastructure and capacity.
- Investment is necessary to produce the required amount of biogas to make Bio-LNG a significant alternative.
- Bio-LNG is more expensive to produce than LNG, and therefore typically requires subsidies to be competitive.

Dimethyl ether (DME) – what is it?

DME can be produced from biomass or fossil sources to create a clean-burning fuel with similar properties as diesel. It can be used in a conventional diesel engine with an adapted fuel system, and deliver the same performance and efficiency.

Advantages

- Tailpipe CO_2 emissions are approximately 8-10% lower than diesel.
- If produced from biomass, well-to-wheel CO_2 emissions are among the lowest of all biofuels.
- Very low emissions of NOx and particulates.
- Compatible with adapted diesel engines.

Disadvantages

- Production capacity and infrastructure are limited and there are no plants of significant size currently producing DME.
- DME has around half the energy content of diesel so a truck needs to carry twice the amount of fuel for the same range.

Alternative fuels – checklist

Are you thinking of adding a truck with an alternative driveline to your business? Choosing the right alternative fuel will depend on many factors. Here are some things to consider when deciding which fuel is the best fit for your business:

- ✓ **Total Cost of Ownership.** This isn't as simple as comparing prices. If one fuel is cheaper but less efficient, it could actually turn out to be more expensive. Will fuel savings cover the cost of additional equipment and vehicles? Will you be affected by tax incentives, service and maintenance costs, local electricity prices, resale value, insurance or payload capacity?
- ✓ **Drive cycles.** Some fuels will only deliver their full benefits if the vehicle is operating in certain conditions so ask yourself if they apply to you. For example, Bio-LNG might be a good choice if you are in the long-haul business whereas an electric vehicle could be suitable in urban distribution.
- ✓ **Infrastructure.** Will new refilling stations be required, and if so, are any such investments forthcoming? Will you need to invest in any new facilities or equipment on your site? If so, take these costs into consideration in your calculations.
- ✓ **Availability.** How secure is the fuel source going forward, and are you confident that there will always be a ready supply?
- ✓ **Reliability.** How well established is the fuel source? Unproven technology comes with increased risk.
- ✓ **Legislation and policy.** Both current and upcoming. Are there any restrictions on diesel-powered vehicles planned? Or government subsidies and incentives for using alternative fuels? Do some thorough research and consult widely.

Alternative fuels

Volvo Trucks' offer

On the next page, we present all the alternative fuels available for Volvo Trucks' customers. This includes an easy overview of each fuel's source of origin, CO_2 emissions and advantages. You can also see which types of fuel are available for each truck model. Please note that this is primarily for Europe and Volvo Trucks' offer can vary between markets.

Alternative energy carriers

Non-fossil fuels are produced from renewable energy sources, while fossil fuels are not. Nuclear energy is considered a non-fossil fuel.

	Fossil fuel sources				Energy from non-fossil sources					
	Diesel	**CNG**	**LNG**	**Electricity**	**Biodiesel**	**HVO**	**Bio-CNG or Compressed Biogas**	**Bio-LNG or Liquefied Biogas**	**Electricity**	**Hydrogen**
Source	Oil	Natural gas	Natural gas	Coal and natural gas	Vegetable oils	Waste and vegetable oils	Biomass and waste	Biomass and waste	Sun, wind, water and nuclear	Sun, wind, water and nuclear
CO_2 emission reduction	Diesel is the reference	Up to 10% reduction	Up to 20% reduction	Up to 20% increase	Between 30% and 70% reduction	Between 30% and 90% reduction	Between 70% and 100% reduction	Between 80% and 100% reduction	Up to 95% reduction	Up to 90% reduction
Advantages	Accessible and relatively cheap	Normally more accessible than LNG	Good energy density	High efficiency	Accessible in some markets	Good performance, can be mixed with diesel	Lower well-to-wheel* value than CNG	Lower well-to-wheel* value than LNG	Zero tailpipe for both CO_2 and NO_X	Zero tailpipe for CO_2
Areas to consider	High CO_2 impact, air pollutants	Lower energy density, high fuel price fluctuations	Infrastructure, high fuel price fluctuations	Infrastructure, how the electricity is produced, relatively cheap	8% lower energy content, higher vehicle maintenance	Access to raw materials, food vs. fuel discussion**	Access to raw materials, lower energy density	Access to raw materials, infrastructure	Access to renewable energy, infrastructure, relatively cheap	Limited infrastructure, high price
Volvo models and engine sizes	All except FM Low Entry	FE 9 liters	FM/FH 13 liters	All except FH16	FL/FE and FM/FH/FH16 5, 8, 13, 17 liters	All except FM Low Entry	FE 9 liters	FM/FH 13 liters	All except FH16	–
Availability	Now	Now	Now	Now	Now	Now	Now	Now	Now	Second half of the decade

* A method to evaluate the efficiency and emissions of an energy source by considering its entire life cycle.
** Some sources of biofuel can be used both in fuel and food production, palm oil is one example. Making it less preferable as it competes with food production.

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