

## HVO

Lab Scale

Bench Scale

Pilot Plant

Demonstration

Production

# HEFA/HVO, Hydroprocessed Esters and Fatty Acids



HEFA (Hydroprocessed Esters and Fatty Acids), also called HVO (Hydrotreated Vegetable Oil), is a renewable diesel fuel that can be produced from a wide array of vegetable oils and fats. The term HEFA or HVO is used collectively for these bio-genic hydrocarbon-based renewable biofuels. HVO is free of aromatics and sulfur and has a high cetane number. It is a so-called drop-in fuel, meaning that it is chemically equivalent to fossil diesel fuel and can be used in existing diesel engines without technical blend walls. One challenge that the production of HVO is facing is to find enough suitable and sustainable feedstock.

## Primary area of use

HVO is an attractive alternative fuel due to the fact that it is chemically equivalent to petroleum diesel and can be used in diesel engines without the blend walls or modifications required for e.g.

biodiesel. However, European diesel standards limit the HVO blend due to density limits and the use of 100% HVO must be approved by the vehicle manufacturer. HEFA can also be used for biojet fuel in a blend with petroleum fuels of up to 50%. Several airlines have done trials with biojet fuels in commercial flights.

The fact that cold properties of HVO can result in clogged fuel filters and injectors may be a limiting factor. However, through isomerization of the HVO, the cloud point of the fuel can be adjusted, lowering the temperature at which wax in the fuel becomes solid.

## Distribution system

HVO is a liquid fuel and distributed as low blends in fossil diesel that are sold at the fuel companies' filling stations. Since HVO can be blended with fossil diesel, investments in new transport or distribution system are not necessary.

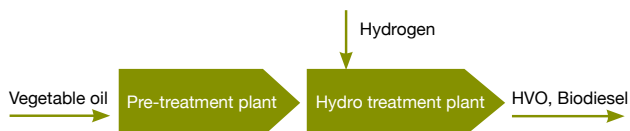
Preem sells HVO in a blend with biodiesel and fossil diesel, which is marketed as Evolution Diesel. Besides Preem, fuel companies such as OKQ8 (DieselBio+), St1 (CityDiesel) and Statoil (Miles Diesel) provide HVO blends of diesel based on imported HVO mainly from Europe. The OKQ8 diesel, BioMax, with 100% HVO, is currently undergoing tests.

## Properties

<b>Chemical formula:</b>	$C_n H_{2n+2}$ (General formula of straight chain paraffinic hydrocarbons)
<b>Heating value:</b>	44 MJ/kg
<b>Density at 15°C 1,013 bar:</b>	775-785 kg/m <sup>3</sup>
<b>Cetane number:</b>	>70

## Feedstock and production

HVO can be produced from many kinds of vegetable oils and fats. This includes triglycerides and fatty acids from vegetable oils, (e.g. rapeseed, soybean and corn oil), tall oil, (a co-product from the pulp and paper industry) in addition to the use of animal fats.



*The simplified production process of HVO from vegetable oil.*

HVO is produced through the hydrotreating of oils, in which the oils (triglycerides) are reacted with hydrogen under high pressure in order to remove oxygen. The hydrocarbon chains produced are chemically equivalent to petroleum diesel fuel. Propane is typically produced as a by-product. Investment costs are much higher for HVO than biodiesel production, which requires large scale production plants to allow the production to be economic. Production may be carried out in stand-alone plants producing only HVO or in integrated plants together with fossil fuels.

Raw materials for HVO production in Sweden are primarily of Swedish and European origin, but are also imported from countries outside of Europe. All HVO must fulfill the sustainability criteria set out in the Renewable Energy Directive (RED). RED sets sustainability criteria for biofuels and bioliquids identical to the Fuel Quality Directive. Availability of sustainable feedstock can be a limiting factor for HVO production, as many raw materials occur in limited amounts and may be subject to competing application areas. Of the HVO sold on the Swedish market, the raw material consists of 35% slaughterhouse wastes, 23% vegetable or animal waste oils, 22% crude tall oil, 15% palm oil and 5% animal fat. Globally, vegetable oil and palm oil are used to a larger extent.

The HVO produced in Sweden is currently (2016) based mainly on crude tall oil. The esterified tall oil used in production comes

from SunPine in Piteå, which is thereafter hydrogenated to HVO at the Preem refinery in Gothenburg together with fossil raw material.

## Current production and use as fuel

The sold amounts of HVO in Sweden have increased rapidly from 45 million litres in 2011 to approximately 439 million litres in 2014.

In 2015, roughly 160 million litres of HVO were produced in Sweden by Preem. The company is currently the only Swedish producer and reports that their Evolution diesel, containing up to 50% HVO, reduces fossil CO<sub>2</sub> emissions by up to 46%. Preem recently extended their production capacity to 220 million litres, and is currently investigating new raw materials in addition to crude tall oil.

Globally, the installed capacity was about 3.8 billion litres per year in 2014. Neste Oil is the largest producer and is using waste fats and vegetable oils such as palm oil, rapeseed oil and soybean oil as feedstock. Production of HVO occurs in Singapore, Europe and the USA.

## Future developments

Several actors have announced their plans to start up or expand HVO production, among them Diamond Green Diesel in the USA, who are expanding their production capacity to over 1 billion litres per year in 2018. The feedstock will be animal fats and used cooking oil.

Since feedstock availability is one of the main challenges for HVO production, there is ongoing research on new resources, for example algae oil, camelina oil and jatropha oil. In Sweden, the potential of lignin for biofuel production has raised interest. Lignin is an abundant resource which could be suitable for bio-gasoline production, which is however not in a strict since a HVO fuel.