

# IEA-Advanced Motor Fuels ANNUAL REPORT 2016

An aerial photograph of a city, likely Stockholm, Sweden, showing a dense urban area with many buildings, a large body of water, and a bridge. In the foreground, there is a lush green forest. A highway with several billboards is visible in the lower part of the image.

Sweden

## Sweden

### Drivers and Policies

The overall goal of Sweden's environmental policy is to be able to pass on to the next generation a society in which major environmental problems have been solved, without increasing environmental and health problems beyond the country's borders. Sweden aims to become one of the world's first fossil-free welfare countries. In order to achieve this, the fossil-fuel dependency of the transport sector needs to be broken. Several measures are needed, such as reducing the total energy demand of the transport sector and ensuring that the remaining energy is both renewable and sustainable.

In 2016, several new proposals to break Sweden's fossil-fuel dependency were presented. The proposals must be effective and provide long-term rules. The long-term climate goal means that by 2045, at the latest, Sweden will have no net emissions of greenhouse gases (GHGs), according to a proposal by the Parliamentary Cross party committee. In more precise terms, the long-term climate goal means that emissions from activities on Swedish territory will be cut by at least 85% compared with emissions in 1990. To achieve net zero emissions, flexibility measures can be included. For the transport sector, a reduction in emissions (not including domestic air travel) of at least 70% by 2030, compared with 2010, has been proposed.

The Government intends to introduce what is known as a bonus-malus system, whereby environmentally adapted vehicles with relatively low carbon dioxide (CO<sub>2</sub>) emissions are awarded a bonus at the time of purchase, and vehicles with relatively high CO<sub>2</sub> emissions are subject to a higher tax (malus).

Other measures are a CO<sub>2</sub>-based fuel tax, a CO<sub>2</sub> differentiated vehicle tax, and environmental car subsidies. The environmental car subsidy depends on the certified CO<sub>2</sub> emissions. Vehicles with a CO<sub>2</sub> emission below a specific 95 grams per kilometer (g/km)-line (counted as a slope according to European Union [EU] regulation No. 443/2009) are exempted from vehicle tax for a period of 5 years. Vehicles with a certified CO<sub>2</sub> level less than 50 g/km also receive a subsidy of 20,000 SEK (\$2,200 US), and zero emission vehicles receive a subsidy of 40,000 SEK (\$4,400 US). Emissions of CO<sub>2</sub> are always considered as tail-pipe emissions.

### Advanced Motor Fuels Statistics

Since 1990, the number of passenger cars has increased from approximately 3.5 million vehicles to more than 4.5 million vehicles. At the same time, GHG emissions have been rather stable at around 13 million tonnes from 1990 to 2007. However, since 2007, emissions have reduced significantly and were about 10 million tonnes in 2015. The main reason for the reduction is the increased energy efficiency of new vehicles.

During the same time period, the increase in the number of vehicles other than petrol- and diesel-fueled has been moderate. The fleet of alternative fueled vehicles was just under 320,000 at the end of 2015, as shown in Figure 1.

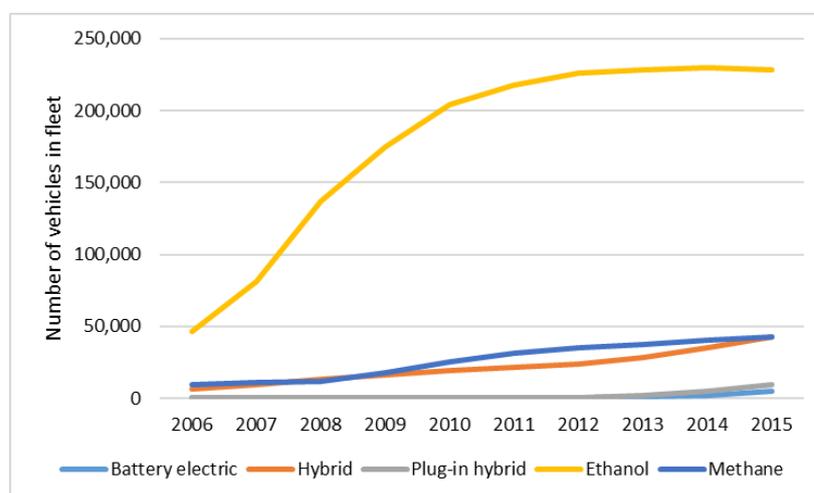


Fig. 1 Number of Advanced Motor Fuel Passenger Cars in the Fleet, 2006–2015

The alternative-fueled vehicles correspond to just under 7% of the total fleet of passenger cars. For light commercial vehicles and heavy-duty vehicles, the corresponding numbers are 2% and 1%, respectively. However, for buses, the share of vehicles registered as other than petrol- or diesel-fueled exceeds 25% of the fleet.

Although flex fuel ethanol vehicles are the most common type of alternative fuel vehicle in Sweden, the ethanol fuel (E85) sold during 2015 only corresponded to approximately 1% of the energy content of transportation fuels sold. The GHG reduction per liter of ethanol has decreased compared with last year as a consequence of measures in other regions close to Sweden. In Germany, fuels with a high reduction percentage have stronger incentives than in Sweden. In 2015, the number of ethanol-fuelled vehicles in Sweden's fleet decreased for the first time. On the other hand, the number of methane-fuelled vehicles has increased steadily over the last 10 years and has now passed 40,000 vehicles, which corresponds to approximately 1% of the fleet.

The use of renewable biofuels for transport in Sweden amounted to almost 13 terawatt hours (TWh), or 14% of the transportation fuels sold during 2015 (Figure 2). Only 2.5 TWh were used in pure form as fatty acid methyl ester (FAME) (1.7 TWh), hydrotreated vegetable oil (HVO) (0.2 TWh), or E85 (0.6 TWh). Methane for transport consists of 70% biogas (1.1 TWh) and 30% natural gas. The remaining portion of the renewable fuels were sold as low blending in either diesel or petrol. Almost 50% of the renewable fuel used in Sweden during 2015 was low blending of HVO in diesel. On average, the renewable share in diesel corresponded to 17%. Some individual diesel products sold on the Swedish market have a renewable share of 50%.

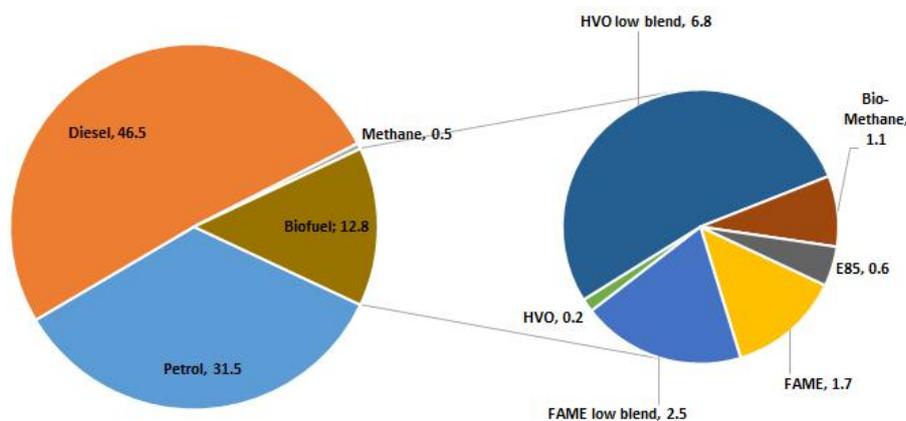


Fig. 2 Fuel Consumption in TWh within the Transport Sector during 2015

Approximately 50% of the feedstock used for producing the renewable fuels consumed in Sweden has also been produced in Sweden. When HVO was introduced on the Swedish market, it was produced from crude tall oil from Sweden, Finland, and the United States. As the demand for HVO increased, the number of feedstocks and countries of origin increased. Today, the raw materials are slaughterhouse wastes, vegetable or animal waste oils, crude tall oil, palm oil, and animal fat in descending order. Most of the feedstocks come from Sweden and other European countries; palm oil comes from Indonesia and Malaysia. The average GHG emissions from HVO use in Sweden during 2015 correspond to 12.0 g carbon dioxide equivalent (CO<sub>2</sub> eq) per megajoule (MJ). For FAME, the corresponding figure was 38.8 g CO<sub>2</sub> eq/MJ.

FAME or biodiesel are primarily produced from either rapeseed oil or used cooking oil. Rapeseed oil is a preferred feedstock because its cold climate properties (i.e., cloud point) are more suitable for the Nordic climate compared with many other vegetable oils. About 94% of rapeseed oil has been imported, as shown in Figure 3.

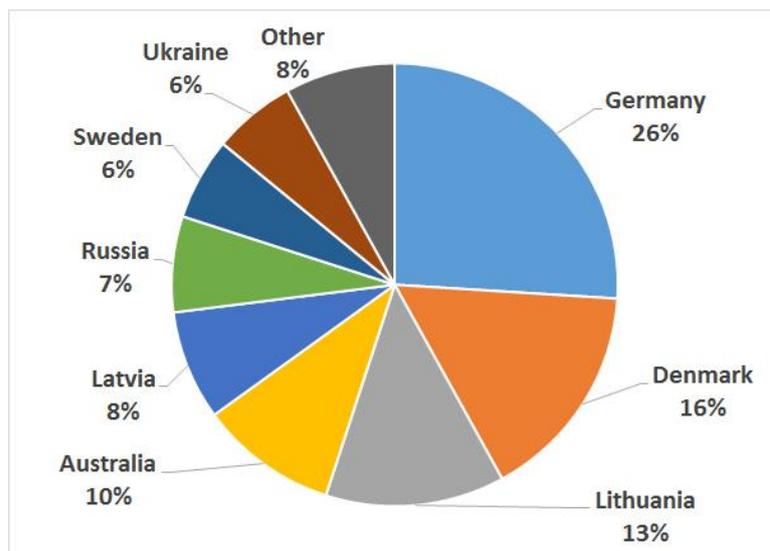


Fig. 3 Country of Origin for Rapeseed Oil Used for FAME Consumed in Sweden in 2015

### **Research and Demonstration Focus**

The Swedish Energy Agency has several energy-related research, development, and demonstration (RD&D) programs:

- Energy & Environment is focused on automotive-related research, innovation, and development activities in the areas of increased energy efficiency, transition to renewable fuels, reduction of local/regional environmental impacts, and areas with potential to strengthen the Swedish and the English automotive industry's competitiveness in a global perspective.
- Research programs for energy efficiency in the transport sector for 2014–2019 on a system level. The call does not accept projects that focus on technology development of vehicle or engine technologies.
- Energy-efficient vehicles in 2015–2019. Both road vehicles and non-road mobile machinery are covered, as well as advanced motor fuels.
- Biofuels programs, thermochemical processes, and biochemical methods.
- Renewable fuels and systems, 2014–2017. The renewable fuels research program is a collaborative program between the Swedish Energy Agency and the Swedish Knowledge Centre for Renewable Transportation Fuels, f3.

### **Outlook**

The goal is set high in Sweden, with a fossil-independent vehicle fleet by 2030 (likely to correspond to a reduction in GHG emissions of 70% compared with 2010), and no net CO<sub>2</sub> emissions by 2045.

Considering the rate of turnover of the vehicle fleet, the use of advanced motor fuels would be necessary to reach these targets. Currently, 13 TWh of renewable fuels are used, but this level would probably need to be doubled by 2045 or earlier.

### **Additional Information Sources**

- Swedish Energy Agency, <http://www.energimyndigheten.se/en/>
- The Swedish Knowledge Centre for Renewable Transportation Fuels <http://www.f3centre.se/>

#### **Major Changes**

In early 2017, the Swedish Government proposed a new climate law with the following targets:

- No later than 2045, Sweden shall have no net emissions of GHGs to the atmosphere.
- Emissions from domestic transport (excluding aviation) shall be reduced by at least 70% by 2030 compared with 2010.

#### **Benefits of Participation in the AMF TCP**

Sustainable and clean energy for transport is necessary to achieve national and international targets. The AMF TCP gives us an arena where we can cooperate with countries worldwide to develop unbiased reports on the effects of various advanced motor fuels.