IEA-Advanced Motor Fuels
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Drivers and Policies

Swiss energy policy is characterized by two fundamental drivers: Phase out the use of nuclear energy, and reduce greenhouse gas emissions. The challenge is to achieve these objectives while maintaining security of supply at affordable prices and reducing carbon dioxide (CO_2) emissions.

The core measures of the revised Energy Act in force since 2017 [1] are therefore to withdraw step by step from the use of nuclear, to reduce electricity consumption, and an expansion of hydropower and new, renewable energy sources. The Swiss Parliament has been debating revision of the CO_2-Act [2] since 2018 and has not reached a conclusion by the end of 2019.

Climate change discussions worldwide and the strikes of young people locally affected parliamentary elections in autumn 2019. Green party candidates won numerous seats and several cities and cantons declared states of climate emergency. Furthermore, the Federal Council has decided in August 2019 to reduce Switzerland's net carbon emissions to zero by 2050. Therefore the new parliament is expected to pass the revised CO_2-Act soon, in which importers of motor fuels will have to compensate for at least 20% of CO_2 emissions by 2025. A portion of the climate protection measures financed by the fuel price must be reserved for electric transport or the development of alternative drive concepts. In the parliament's view, this can contribute to the long-term reduction of transport-related CO_2 emissions. To finance the respective measures, the revised Act is expected to specify that fuel price can be increased up to €0.09 ($0.10 US).

CO_2 Emission Regulations for Cars

Since 2015, Swiss car importers must pay a penalty if the average new passenger car fleet exceeds 130 g CO_2/km. In 2018, the average was 137.8 g CO_2/km, and the penalty amounted to €27.9 million ($31.7 million US) [3]. In alignment with the European Union Commission, the Federal Council aims, from 2021 to 2024, to reduce average CO_2 emissions from passenger cars to 95 g CO_2/km and from light commercial vehicles (vans up to 3.5 metric tons) to 147 g CO_2/km [2]. Further reductions are foreseen for 2025 to 2029 and the use of synthetic CO_2-neutral fuels should be allowed to achieve the limit values.

CO_2 Emissions Compensation: Motor Fuels

Since 2014, importers of fossil motor fuels must use domestic measures to compensate for CO_2 emissions generated by the entire transportation

sector [4]. The compensation rate was established at 2% in 2014, will be raised to 10% in 2020, and will probably be 20% by 2025. Importers of fossil motor fuels may carry out their own projects or acquire certificates. The Swiss Petroleum Association established the Foundation for Climate Protection and Carbon Offset (KliK). It launches and subsidizes projects to reduce CO_2 emissions in fields such as transportation, industry, buildings, and agriculture. Another measure to reduce CO_2 emissions is to blend fossil fuels with biofuels.

Mineral Oil Tax Reduction for Natural Gas and Biofuels

To support the target for CO_2 emissions, a reduction—or even an exemption—for environmentally friendly motor fuels was enacted in 2008. Biofuels that satisfy minimum environmental and social standards are completely or partially exempt from the mineral oil tax. As a result, the tax reduction for biofuels is up to €0.64 ($0.72 US) per liter (L) in comparison with fossil fuels. The mineral oil tax reduction is only valid until 2020 [5].

Advanced Motor Fuels Statistics

Final total energy consumption in Switzerland in 2018[1] amounted to 830,880 terajoules, of which 36.3% was transport fuels (Figure 1) [6]. Compared to 2017, fuel consumption increased by 2.1%. Some changes in specific applications were made in 2018: diesel, +1.3%; gasoline, −1.6%; and aviation fuels, +5.7%. In the same period, the total amount of engine-driven vehicles increased by 1.0% to 6,113,791. Fuel consumption by vehicles dropped by 1.0%. With a share of 52.2% in 2018, the consumption of diesel was higher than the use of gasoline (44.1%), biofuels (3.4%) and natural gas, including biogas (0.3%). All fossil fuels were imported.

Electricity is used for railroad transportation, and a negligible amount is used for electric cars. Despite an impressive annual increase of electric vehicles (2015, +70%; 2016, +42%; 2017, +36%, and 2018, +32%), the total amount is still very small (19,181 passenger cars) [7].

1 At the time this report was prepared, only data from 2018 were available.

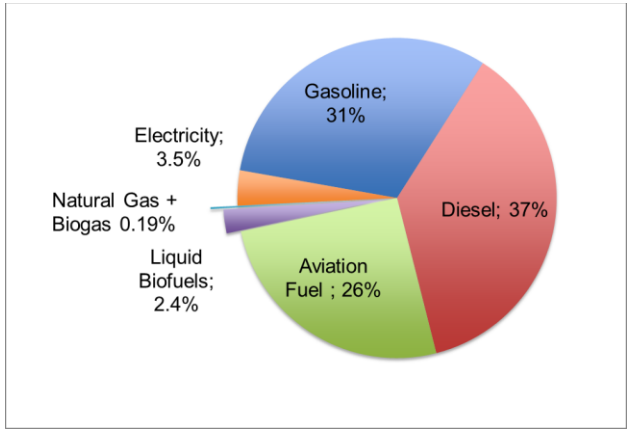

Fig. 1 Shares of Energy Sources in Energy Consumption for the Transportation Sector in Switzerland in 2018 [6]

As mentioned, importers of fossil motor fuels started blending fossil fuels with biofuels in 2014, due to the obligation to reduce CO_2 emissions. Within five years, the use of liquid biofuels rose from 29.4 million L to 248.5 million L. In 2018, 158.1 million L biodiesel and 56.3 million L bioethanol were used (Figure 2). Hydrotreated vegetable oil has only been used in Switzerland since 2016 (2018: 34.1 million L). Pure vegetable oil fuel is almost negligible (0.038 million L). Upgraded biogas as a transport fuel remained at a low level of 2.8 million kg [8].

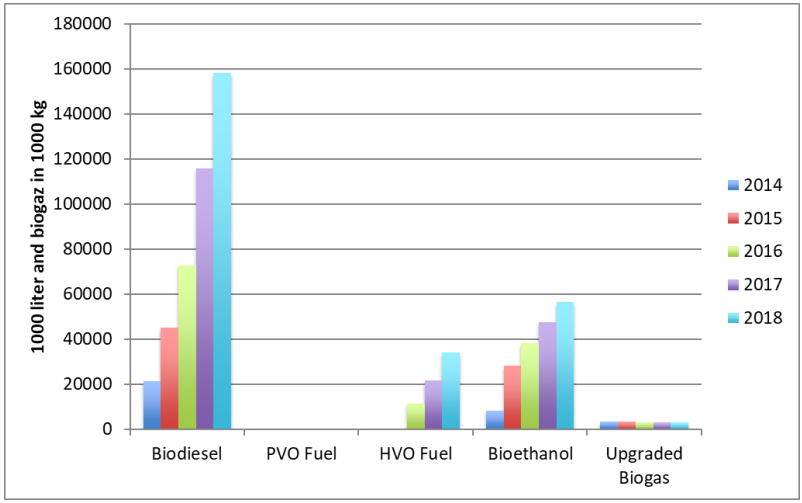

Fig. 2 Development of the Use of Biofuels as Motor Fuels in Switzerland, 2011–2015

Only 12.5 million L of biodiesel was produced in Switzerland. The other 145.5 million L was imported (73% from Germany, and the rest from nine other countries). All bioethanol is imported (Poland, 45.2%; Norway, 15.8%; Sweden, 11.8%; Germany, 11.0%, Holland, 8.6%; and Italy, 7.6%) [9]. Hydrotreated vegetable oil is imported from the United States, 94.6%; and Finland, 5.4%).

The total amount of biogas produced and used in Switzerland in 2018 was 113 million kg. Only 25.6 million kg has been upgraded and fed into the natural gas grid. From this, a small amount (2.8 million kg) has been sold as biogas for cars, and the rest for heating [8]. All biogas used as motor fuel in cars is upgraded biogas fed into the natural gas grid. Therefore, cars need no special requirements for biogas as a fuel. Figure 3 shows the development of the use of biogas and natural gas as motor fuels in cars. Despite an increasing amount of biogas fed into the natural grid, the demand for it as a motor fuel remains at a low level while 89% of biogas is used for residential heating [10].

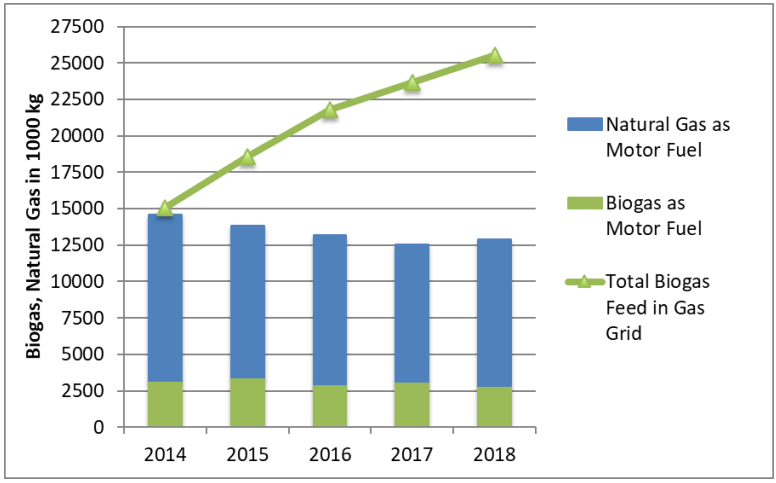

Fig. 3 Development of the Use of Natural Gas and Biogas as Motor Fuel for Cars and Total Upgraded Biogas Fed into the Natural Gas Grid (green line)

Research and Demonstration Focus

In the research, development, and demonstration funding framework of the Swiss Federal Office of Energy, three programs — bioenergy, combustion, and mobility — support AMF research activities [11]. In addition, Swiss Competence Centers for Energy Research support coordination, improve collaboration, and increase capacity building. One center is dedicated to

mobility [12] and another to bioenergy [13], including liquid and gaseous biofuels. Examples of ongoing research projects are detailed below.

Investigations of the suitability of DME as an alternative fuel in heavy-duty vehicles. Methanol/dimethyl-ether (DME) is a fuel well suited for compression ignition engines, and it can be produced from several renewable sources. To use DME, the fueling system needs to be adapted. Because DME contains oxygen, an interesting NO_x-soot-efficiency trade-off can be expected, especially if exhaust gas recirculation is used. Within this project, a modern heavy-duty engine will be optimized for the use of DME.

Diesel engine with neat OME_{3-6}. Polyoxymethylene-dimethylether (OME) fuel has a high potential for reducing CO_2. The combustion characteristics of OME increase efficiency and simplify the exhaust after-treatment system, which increases the market chances of the more expensive fuel. This project's goal is to lay out an optimum OME engine and after-treatment configuration. This procedure includes detailed optical investigations, modelling of the combustion process, and testing of bench experiments.

Investigations with Diesel-butanol blend fuels. Diesel-butanol blends are durable with a reduced heat value, increased oxygen content, lower cetane number and no aggressive or corrosive properties. With the lower butanol blending ratios (< 10%), no operating differences are noticeable in the vehicle. Higher butanol contents (> 30%) result in worse cold start behavior, higher irregularity of engine running, and less dynamic performance at part-load operation. Emissions are unchanged with modern exhaust after-treatment systems.

Outlook

The new CO_2-Act will accelerate both use of biofuels and sales of electric and hybrid vehicles. By 2025, the petrol industry has to compensate for 20% of CO_2 emissions. In addition, the average of CO_2 emissions from passenger cars has to be reduced by 15% compared to 2021; after 2030, the average must be reduced by 37.5 %. The Swiss gas industry has set a goal to achieve a 30% share of renewable gas in the gas grid by 2030. To meet this goal different sources of renewable gas are needed. This includes power-to-gas technologies to produce hydrogen that can be methanated and fed in the natural gas grid. The Swiss engine industry and research institutes are intensively engaged in developing engines that can use natural gas/biogas and renewable liquid and gaseous fuels for passenger, long-haul, marine transportation and other off-road applications.

Additional Information Sources

[1] The Federal Council, 2017, “730.0 Energiegesetz (EnG).”
[2] Federal Office for Environment (FOEN), “Totalrevision CO_2 Gesetz.”
[3] SFOE, 2019, “CO2-Emissionen von Neuwagen …im Jahr 2018.”
[4] FOEN, 2012, “CO_2 emission compensation: motor fuels.”
[5] Mineralölsteuergesetz (MinöStG), Stand: Jan. 1, 2012.
[6 SFOE, 2019, “Gesamtenergiestatistik 2018.”
[7] Swiss Federal Statistical Office (BFS), 2019, “Mobility and Traffic.”
[8] SFOE, 2019, “Schweizerische Statistik erneuerbarer Energien 2018.”
[9] Swiss Custom Administration, 2019, “T2.8 Biogene Treibstoffe 2018”
[10] Association of the Swiss Gas Industry, 2019, “VSG-Jahresstatistik”
[11] www.bfe.admin.ch
[12] www.sccer-mobility.ch
[13] www.sccer-biosweet.ch