IEA-Advanced Motor Fuels
ANNUAL REPORT 2020

Switzerland

Technology Collaboration Programme
by iea

Switzerland

Drivers and Policies

After three years of debating revision of the CO_2-Act, the Swiss Parliament passed it in September 2020 [1]. The revised act is a measure to achieve the climate targets of the Paris Agreement and to meet the goal of the Federal Council to reduce Switzerland's net carbon emissions to zero by 2050. Three months later, an optional referendum came to pass. In Switzerland, with a total of 5.5 million voters, only 50,000 signatures are needed to launch a referendum against a new act. Thus, the voters will decide whether to accept or reject the revised CO_2-Act.

Many measures concern the building sector, where fossil-fueled heating systems will be banned in new buildings and a levy of up to €200 per ton CO_2 ($220 US) may be imposed. The mobility sector must also make a substantial contribution to reducing CO_2 emissions. In alignment with the European Union Commission, in Switzerland step-by-step reduced CO_2 emission regulations apply for new passenger cars and for light and heavy-duty vehicles. Importers of fuels have to compensate for an increasing share of CO_2 emissions. 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. In order to finance the corresponding measures, the fuel price can be increased by up to €0.09 ($0.10 US) until 2024 and €0.11 ($0.12 US) after 2025.

It is expected that this will lead to a strong increase in electricity demand for electromobility and heating of buildings (heat pumps). This challenges the energy law in force since 2017 [2], which stipulates a gradual phase-out of nuclear energy, which today covers about 35% of electricity demand in Switzerland. The targets can therefore only be achieved by reducing electricity demand in other areas, and through an expansion of hydropower and new, renewable energy sources.

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 based on the New European Driving Cycle (NEDC). In 2019, the average was 138.1 g CO_2/km, and the penalty amounted to €78.1 million ($86.8 million US) [3]. As of 2021, reduced CO_2 emission regulations apply for new cars. The average level of new passenger cars may not exceed 95 g CO_2/km) and light commercial vehicles (vans up to 3.5 metric tons) 147 g CO_2/km. The limit values will be adjusted and measured with the new World Harmonized Light-Duty Vehicles Test Procedure (WLTP).

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, and was raised to 10% in 2020. In the new CO2-Act, 15% must be compensated from 2021 and 20% from 2025. Importers of fossil motor fuels have to achieve a minimum of 3% by electrification and CO_2-neutral powertrains. For the rest they 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. This has led to a sharp increase in sales of liquid 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 requirements are completely or partially exempt from the mineral oil tax. As a result, the tax reduction for biofuels is up to €0.64 ($0.80 US) per liter (L) in comparison with fossil fuels. The mineral oil tax reduction was initially valid until 2020 and has now been extended until 2023 [5]. To offset the loss of tax revenue from this tax cut, the fossil fuel tax will be increased until 2028.

Advanced Motor Fuels Statistics

The following numbers and statements are all based on 2019 statistics. This therefore does not represent the impact of the Covid-19 pandemic in 2020.

Final total energy consumption in Switzerland in 2019 amounted to 834,210 terajoules, of which 36.2% was transport fuels (Figure 1) [6]. Compared to 2018, fuel consumption increased only by 0.1%. Only minor changes in specific applications were made in 2019: diesel, 0.0%; gasoline, −0.8%; and aviation fuels, +1.0%. In the same period, the total amount of engine-driven vehicles increased by 0.8% to 6,160,262. Fuel consumption by vehicle has not changed. With a share of 52.4% in 2019, the consumption of diesel was higher than the use of gasoline (43.8%), biofuels (3.5%) and natural gas, including biogas (0.3%). All fossil fuels were imported.

Electricity is used for railroad transportation, and a small amount is used for electric cars. Despite an impressive annual increase of electric vehicles (2016, +42%; 2017, +36%, and 2018, +32%, 2019, + 50 %), the total amount is still very small (28,716 passenger cars are a share of 0.5% of total) [7].

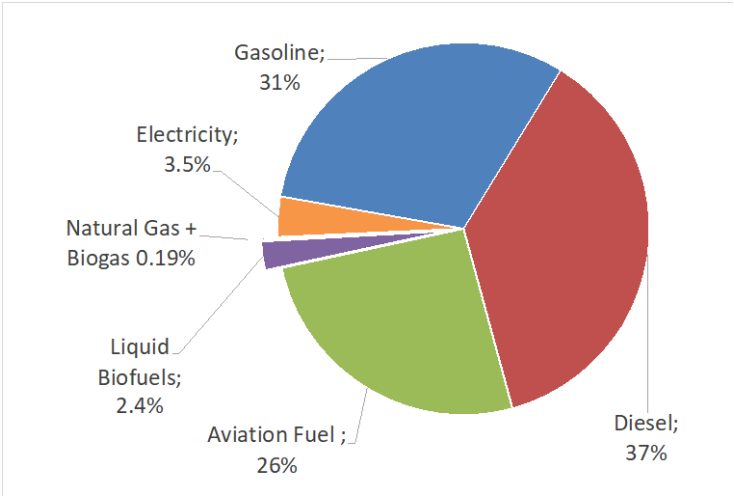

Fig. 1. Shares of Energy Sources in Energy Consumption for the Transportation Sector in Switzerland, 2019 [6]

As mentioned, importers of fossil motor fuels started blending fossil fuels with biofuels in 2014, due to the obligation to reduce CO_2 emissions. In the last five years, the use of liquid biofuels rose from 73.3 million L to 260.2 million L. In 2019, 167.5 million L biodiesel and 64.2 million L bioethanol were used (Figure 2). Hydrotreated vegetable oil has only been used in Switzerland since 2016 (2019: 28.5 million L). Pure vegetable oil fuel is almost negligible (0.043 million L). Upgraded biogas as a transport fuel remained at a low level of 3.0 million kg [8].

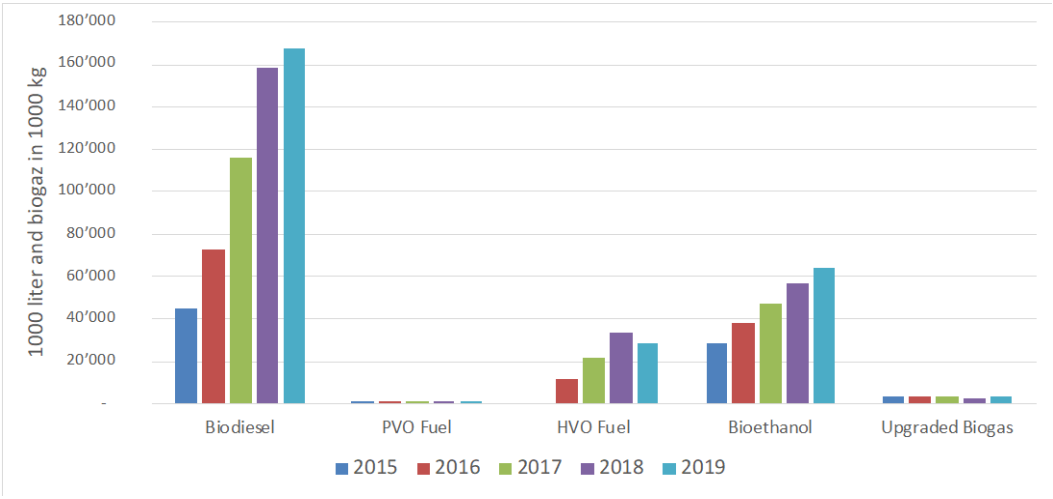

Fig. 2. Development of the Use of Biofuels as Motor Fuels in Switzerland, 2015–2019

Only 13.0 million L of biodiesel was produced in Switzerland. The other 154.5 million L was imported (Germany, 50.9%; Japan, 21.4%; France, 13.0%; China 10.4% and the rest from five other countries). All bioethanol is imported (Poland, 34.8%; Sweden, 18.0%; Norway, 15.6%; Italy, 14.3%; Germany, 10.8%, Holland, 8.6%; and the rest from three other countries) [9]. Hydrotreated vegetable oil is imported from the United States, 99.8%; and China, 0.2%).

The total amount of biogas produced and used in Switzerland in 2019 was 109 million kg. Only 28.4 million kg has been upgraded and fed into the natural gas grid. From this, a small amount (2.9 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].

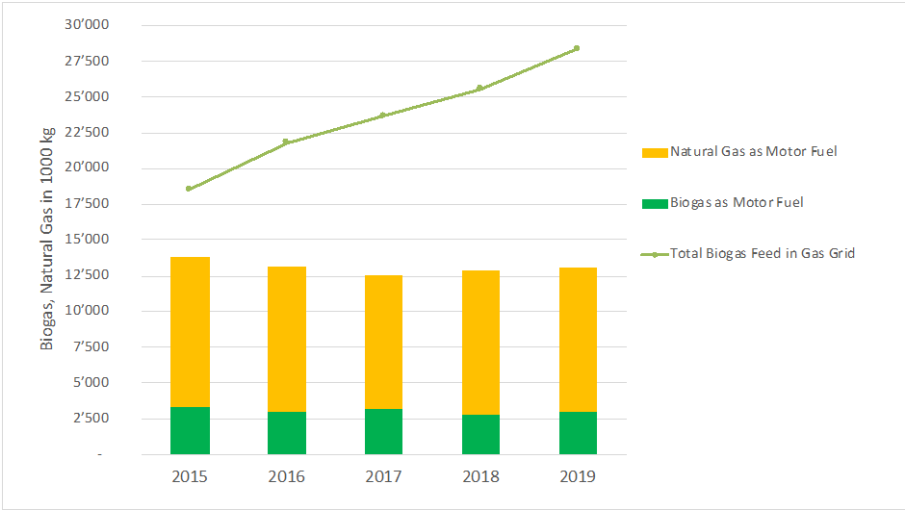

Fig. 3. Development of the Use of Natural Gas and Biogas as Motor Fuel for Cars and Total Upgraded Biogas Fed into the Natural Gas Grid (green line)

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.

Development of alternative biogas transport solutions

In Switzerland, there is currently still a large unused biomass energy potential, especially of farmyard manure from rather small-scale farms. Many of these sites are geographically difficult to develop and are not connected to the gas grid, so road transport of biomethane is an alternative. The organization fahrBiogas has analyzed the economic viability of eight different scenarios for small to medium-sized biogas plants (20 Nm3/h to 80Nm3/h raw gas), as well as explanations on how to deal with technical or regulatory hurdles [14]. It can be seen that in all scenarios, raw biogas production represents the largest cost block, followed by — depending on the scenario — biomethane production or transport. Transportation costs account for 14% to 38% of the total costs. The calculations show that transport by road can be economical for small or medium-sized biogas plants. However, since many factors have an influence, each case must be considered individually. As a general guard rail, the calculations made on the basis of current assumptions show that the raw gas costs must be lower than €0.10/kWh ($0.12 US) and the biomethane processing costs lower than €0.07/kWh ($0.08 US) in order to finance a transport solution at current energy sales prices.

Use of LBG (liquefied biogas) for Swiss heavy-duty transport is investigated in a pilot project. The conditions under which the use of LBG is energetically, technically and economically feasible are evaluated. For this purpose, all energetically relevant influencing variables in the entire value chain of a concrete LBG source of supply are examined, summarized and evaluated in a well-to-wheel analysis. Additionally, to the legal PEMS-RDE (Portable Emission Measuring System for Real Drive Emissions) measurements of the investigated trucks, measurements of several non-legislated components are carried out in the real-world application by means of a portable FTIR (Fourier-Transform-Infrarotspektrometer). [15]

Fig. 4. Truck Fueled with Liquefied Biogas and with FTIR-PEMS Measurement Installation (Source: AFHB)

Investigations of the suitability of DME as an alternative fuel in heavy-duty vehicles. 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. [16]

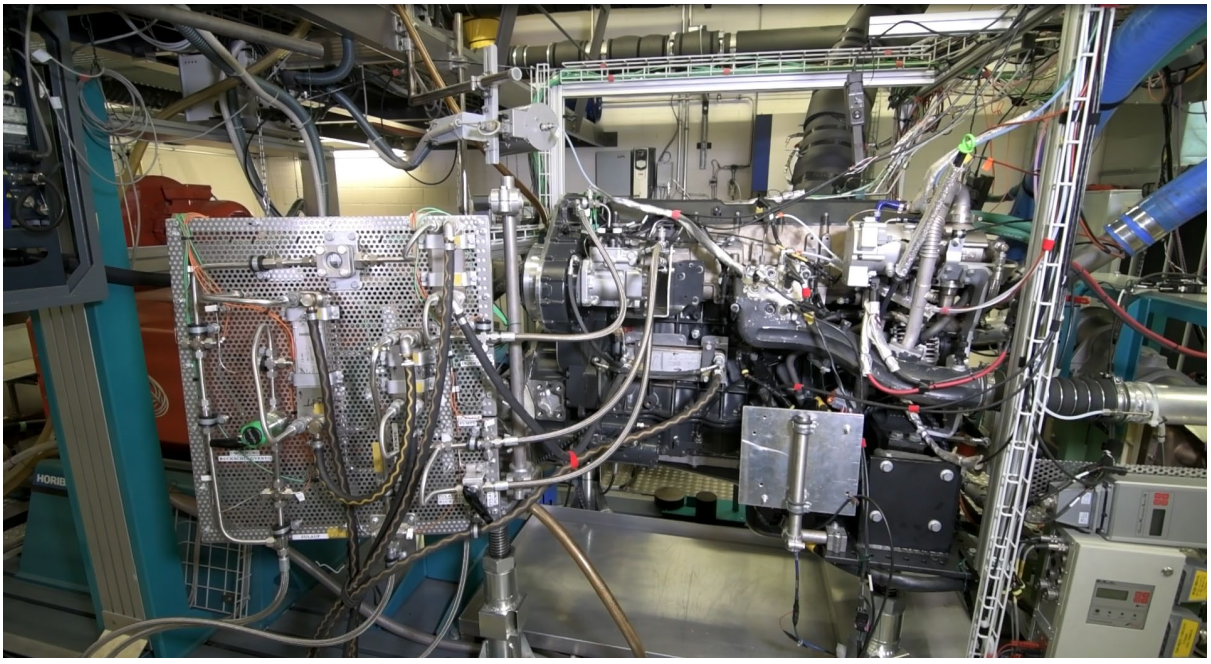

Fig. 5. Test Bench with 6-Cylinder Heavy Duty Engine Fueled with DME. The Low Pressure DME Circuit Feeding the High Pressure Common Rail Pump is on the Left. (Source: EMPA)

New combustion processes for hydrogen engines are investigated in two projects. In a computational study, the potential of a hydrogen engine operated at stoichiometry with exhaust gas dilution is explored. Data on achievable power density, conversion efficiency and minimal NO_x-emissions and a comparative assessment vs. the well-understood lean-burn concept will be provided. In a second project, a combustion engine operating with hydrogen as fuel by using the multi-jet ignition will be built. The goal is to operate the engine with higher air/fuel ratio range and meet the EURO 7 standards without any exhaust after-treatment system. [17,18]

Outlook

Sales of passenger cars with electric drive systems will continue to grow strongly. The expanded range of vehicles on the market, the massive expansion of electric charging stations and tax relief all contribute to this. Demand for large electric vehicles will be mainly confined to the municipal sector and to public transport. Trucks with fuel cells are also being tested, and power-to-gas plants are being built to supply them with hydrogen. The engine industry and research institutes are developing and testing combustion and engine concepts for the use of different fuels with a low GHG footprint. In the past, the focus was on natural gas and biogas and it has recently changed to a variety of electro-fuels. This include H_2, methanol, NH_3, DME, and OME. The engines developed for these fuels are intended for long-distance transport, marine transport and different off-road applications.

Additional Information Sources

[1] Federal Office for Environment (FOEN), "Totalrevision CO_2 Gesetz"
[2] The Federal Council, 2017, "730.0 Energiegesetz (EnG)"
[3] SFOE, 2019, "CO_2-Emissionen von Neuwagen …im Jahr 2019"
[4] FOEN, 2012, "CO_2 emission compensation: motor fuels"
[5] Mineralölsteuergesetz (MinöStG), Stand: July 1, 2020
[6] SFOE, 2019, "Gesamtenergiestatistik 2019"
[7] Swiss Federal Statistical Office (BFS), 2020, "Mobility and Traffic"
[8] SFOE, 2020, "Schweizerische Statistik erneuerbarer Energien 2019"
[9] Swiss Custom Administration, 2020, "T2.8 Biogene Treibstoffe 2019"
[10] Association of the Swiss Gas Industry, 2020, "VSG-Jahresstatistik"
[11] www.bfe.admin.ch
[12] www.sccer-mobility.ch
[13] www.sccer-biosweet.ch
[14] https://www.aramis.admin.ch/Grunddaten/?ProjectID=41447
[15] https://www.aramis.admin.ch/Grunddaten/?ProjectID=47462
[16] https://www.aramis.admin.ch/Grunddaten/?ProjectID=41773
[17] https://www.aramis.admin.ch/Grunddaten/?ProjectID=47343
[18] https://www.aramis.admin.ch/Grunddaten/?ProjectID=44967

Major changes
Swiss Parliament passed in September 2020 a revised CO_2-Act. The transport sector is thus also being burdened with further requirements aimed at reducing CO_2 emissions.
A referendum will be held before it enters into force.
Swiss car importers must pay a penalty if the average new passenger car fleet exceeds 130 g CO_2/km. In 2020 they had to pay €78.1 million ($86.8 million US), the highest penalty ever. A total of 314,000 new vehicles were registered and the average was 138.1 g CO_2/km.

Benefits of participation in AMF
The future of internal combustion engines depends among other things on the successful market introduction of CO_2-reduced fuels. The TCP AMF is a pioneer in researching and describing novel fuels and their application, benefits and effects in terms of efficiency and emissions. AMF is a unique source of information and a platform for international exchange of experience and cooperation in this field.