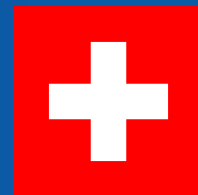


Country Reports

IEA Bioenergy: 10 2021



This report was prepared from the 2021 IEA World Energy Balances and Renewables Information, combined with data and information provided by the IEA Bioenergy Executive Committee and Task members¹. Reference is also made to FAOstat as well as data from national statistics. All individual country reports were reviewed by the national delegates to the IEA Bioenergy Executive Committee, who have approved the content. General background on the approach and definitions can be found in the central introductory report for all country reports.

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HIGHLIGHTS

- Renewables make up 22 % of Switzerland's *total energy supply* in 2019. The renewable energy share in *final energy consumption* is 28%². Around 30% of renewable energy originates from biomass and renewable fraction from waste.
- Solid biomass represents around half of bioenergy; the use of renewable MSW for energy is high in Switzerland, representing a third of total bioenergy.
- The use of solid biofuels compared to the domestic forest area in Switzerland is modest and there is room for increased mobilization.
- The main application of bioenergy is in renewable heat, particularly in direct heating (residential, services and industry). Around two thirds of distributed heat is produced from waste (which is around half biobased) and another 16% from solid biomass.
- Electricity production in Switzerland is dominated by hydropower and nuclear energy, with a modest role for bioenergy (mostly through CHP plants). The role of solar power is growing.
- The role of biofuels in transport has increased in the past 5 years to a level of 3% in transport energy consumption. Electricity use for transport is also relevant in Switzerland (almost 5 % of transport energy), particularly through rail.

¹ While data for 2020 are starting to become available at national level, it was decided to consider trends up to 2019 for good comparability and benchmarking between the different IEA Bioenergy member countries. Care should also be taken when using 2020 data for analysing trends as these data are distorted by the COVID19 Pandemic.

² The difference between the share of renewables in supply and consumption relates to unused heat from power plants (which is counted in energy supply, but not in final consumption).

COUNTRY PROFILE

Population and land use

Switzerland is a largely mountainous country in the centre of Europe; however, it is not a member of the European Union. Switzerland has a total land area of 39.5 thousand km² and a population of 8.2 million people, which represents a relatively high population density of 217 persons per km².

The Swiss climate is generally temperate. Around one third of the land area is forest land (*of which 17% protected*). 38% is agricultural land, three quarters of that being permanent meadows/pastures and one quarter arable land.

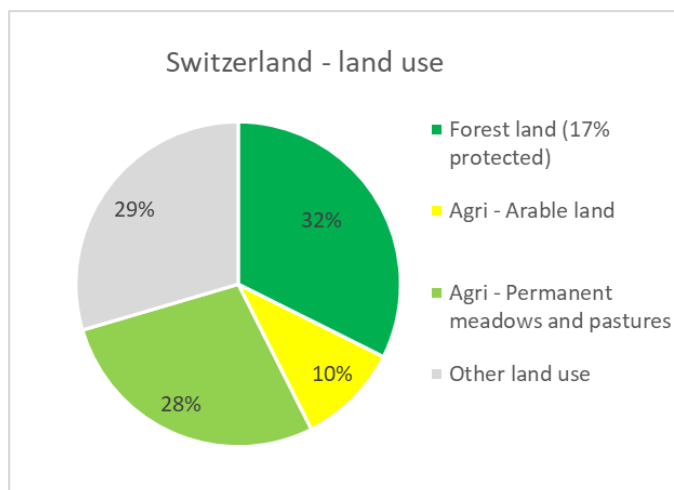


Figure 1: Land use in Switzerland (2018 figures - Source: FAOstat)

Final energy consumption

Overall final energy consumption in Switzerland (*also including non-energy use of oil, natural gas and coal in industry*) equates 2.1 tonnes of oil equivalent (toe) per capita, which is somewhat below the average of IEA Bioenergy member countries. Particularly industry has a relatively modest role compared to other countries.

Table 1: Distribution of the final consumption of energy carriers by sector in Switzerland (2019 figures - Source: IEA (2021) World Energy Balances and Renewables Information)

Final consumption energy carriers	Toe/capita (2019)	% of total	Median* (toe/capita)
Industry (energy use)	0.40	19%	0.67
Industry (non-energy use)	0.05	2%	0.21
Transport	0.66	31%	0.69
Residential	0.59	28%	0.57
Commercial & public services	0.37	18%	0.34
other	0.04	2%	
Total	2.11		2.34

* Median of the 25 member countries of IEA Bioenergy³

³ Comparative figures of the different IEA Bioenergy member countries are discussed in the central Countries' Report.

NATIONAL POLICY FRAMEWORK IN SWITZERLAND

TARGETS AND STRATEGIES

Today Switzerland has a secure and cost-efficient supply of energy. Economic and technological developments as well as political decisions at home and abroad are currently leading to fundamental changes in the energy markets. To prepare Switzerland for these, the Federal Council has developed the **Energy Strategy 2050**. This should enable Switzerland to make advantageous use of the new starting position and maintain its high supply standard. At the same time the Strategy contributes to reducing Switzerland's energy-related environmental impact.

In the wake of the Fukushima reactor disaster in 2011, the Federal Council and Parliament decided that Switzerland is to withdraw from the use of nuclear energy. This decision, together with various other profound changes in the international energy sector, meant that Switzerland's overall energy system would have to be restructured. For this purpose, the Federal Council prepared a new energy policy called "Energy Strategy 2050".

The implementation of Energy Strategy 2050 also requires amendments to legal and policy instruments:

- **Electricity Networks Strategy:** to facilitate the further development of the electricity networks, in December 2017, the Parliament adopted amendments to the **Federal Electricity Act** and the **Federal Electricity Supply Act**.
- **Climate policy:** in the Paris Agreement on Climate Change, Switzerland undertook a commitment to halve its greenhouse gas emissions versus the 1990 level by 2030. To accomplish this, the existing **Federal CO₂ Act** has to be revised for the period beyond 2020. In 2019 the Federal Council resolved that, as of 2050, Switzerland is to reduce its net greenhouse gas emissions to zero (zero net emissions target). This means it is aiming to meet the internationally agreed goal of limiting global climate warming to a maximum of 1.5° C versus the pre-industrial period. In June 2021 the revised CO₂ Act was rejected from the Swiss voters (see also below).
- The **Energy Perspectives 2050+** (EP 2050+) analyse in a net-zero emissions scenario (ZERO) how to develop an energy system that is compatible with the long-term climate goal of net-zero greenhouse gas emissions by 2050 and, at the same time, ensures a secure energy supply. Several variants of this scenario are considered. They differ in their combination of technologies and the speed of the renewable energy transition in the electricity sector.
- **Revision of the Federal Electricity Supply Act:** the aim behind the ongoing revision of the Federal Electricity Supply Act is to bring about the full liberalisation of the electricity market. At the same time, the Federal Energy Act is also to be adapted. Here, the intention is to implement measures to support the liberalisation of the market by providing more attractive incentives for investing in domestic renewable energy, and thus to strengthen Switzerland's supply security.

Table 2: Switzerland's 2035 and 2050 renewable energy indicative values for the electricity production.

Sector	Share of electricity production	Share of electricity production
	2035 (in GWh)	2050 (in GWh)
New renewable energies (incl. biomass) without hydropower	4'400	11'400
New renewable energies (incl. biomass) with hydropower	37'400	No target

The main support measure for electricity production from renewable sources (feed-in remuneration) ends at the end of 2022 according to the current Act. The Federal Council has proposed a revision of the Act with new support measures for renewable energy. The Federal Parliament has also proposed a revision of the Act (Pa. Iv. 19.443 Girod). The revised Act is expected for 2023.

The climate targets, on which the support for bioenergy especially in the heating sector is also dependent, were part of the revised CO₂ Act. In September 2020, the Swiss parliament passed the CO₂ Act, which aims to achieve the objectives of the Paris Climate Agreement by halving Switzerland's CO₂ emissions by 2030 compared to 1990. On 13 June 2021 Swiss voters did not follow the federal government and Parliament and rejected the revised CO₂ Act. The federal government and Parliament must now continue their efforts and find new solutions to ensure that Switzerland will meet its commitments under the Paris Agreement.

A description of renewable energy and climate policies and measures in Switzerland is available at the IEA's Policies and Measures Database [2] and on the websites of the Swiss Federal Office of Energy [3] and the Swiss Federal Office for the Environment [4].

Specific policies related to renewable electricity, renewable heat and transport biofuels will be highlighted in the chapters about the role of bioenergy in different sectors.

THE CONTRIBUTION OF BIOENERGY IN NATIONAL ENERGY SUPPLY

TOTAL ENERGY SUPPLY

The total energy supply (TES) of Switzerland in 2019 amounted to 1,023 petajoule (PJ). Fossil energy represents around half of Swiss TES. Oil products account for 36% (364 PJ) and natural gas accounts for 12% (123 PJ). A minor amount of coal (4 PJ) is used in industry. The statistics also features 28% or 290 PJ of nuclear energy in nuclear power stations (which represent 35 % of national electricity production). Mind that the role of nuclear energy in final energy consumption is lower (~ 12%) as total energy supply also includes unused waste heat, which distorts the picture somewhat. Renewable energy sources have a share of 22.5% in total energy supply or 230 PJ, of which bioenergy represents 35% (82 PJ). Hydropower provides most renewable energy (137 PJ or 13.4% of TES), while solar energy represents 1% of TES (10 PJ).

In 2019 there was also a substantial amount of electricity (23 PJ) that is exported to neighbour countries.

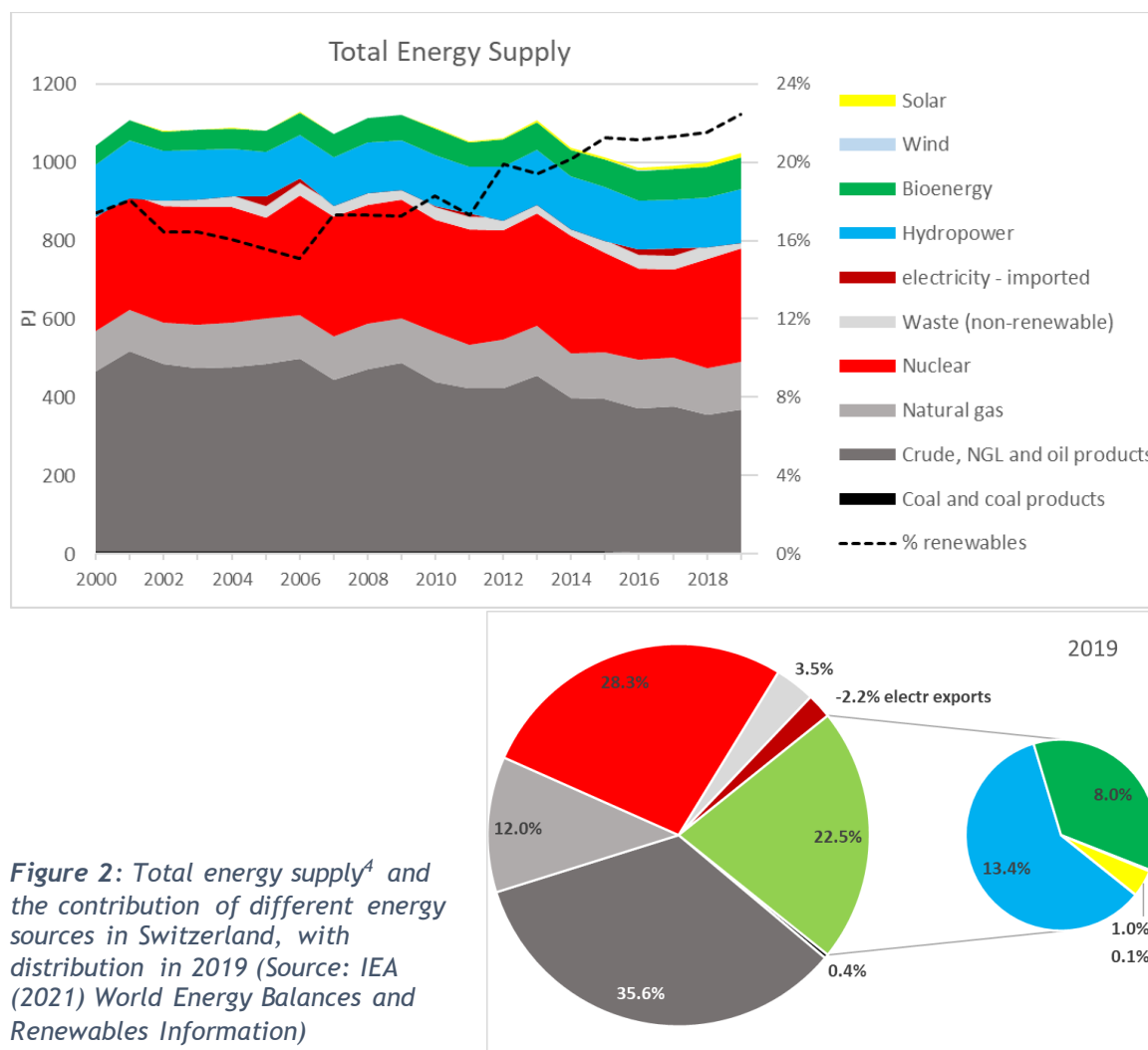


Figure 2: Total energy supply⁴ and the contribution of different energy sources in Switzerland, with distribution in 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)

⁴ Total energy supply refers to the use of resources. In terms of the role in the energy system this distribution overestimates the role of resources producing electricity with a high share of unused waste heat (like nuclear plants).

The total energy supply in Switzerland was quite stable around 1100 PJ until 2013 and dropped somewhat afterwards to around 1000 PJ. The share of oil products decreased steadily from 45% of TES (>500 PJ) in the early 2000s to around 35% (360 PJ) in recent years. The share of natural gas was fairly stable around 11-12% (120 PJ). Nuclear energy fluctuated between 230 and 300 PJ in the past decades.

After a slight decline in renewable energy in the early 2000s, between 2005 and 2019 the share has increased from 15% to 22% of TES. Hydropower has always been the dominant type of renewable energy, slightly fluctuating between 120 and 140 PJ, around 13% of Swiss TES. Bioenergy has steadily increased from 50 PJ in 2000 to 80 PJ in recent years. Solar power saw a steady growth from 1 PJ in 2008 to 10 PJ in 2019. The contribution of wind energy is marginal so far (0.5 PJ).

Figure 3 shows the evolution of the different types of bioenergy. As indicated, bioenergy in Switzerland has steadily increased in the past decades. Solid biomass provides more than half (44 PJ), but renewable municipal waste is also very important at 24 PJ. The next item is liquid biofuels (7.7 PJ), followed by biogas (5.6 PJ).

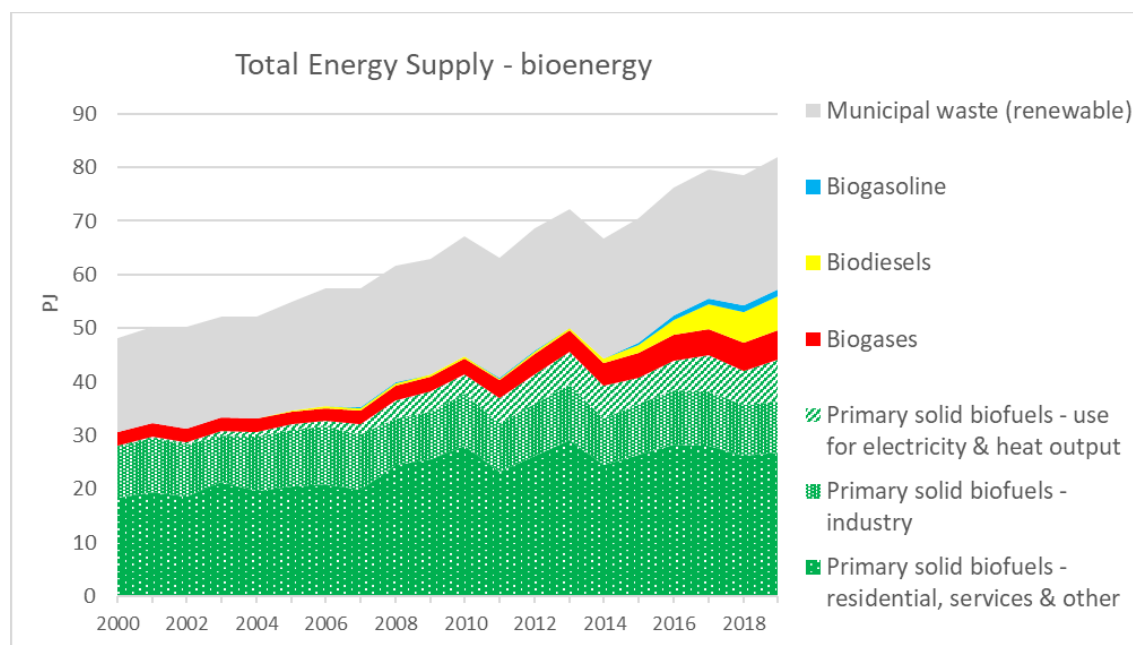


Figure 3: Development of total energy supply from bioenergy in Switzerland 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)

Evolution of the bioenergy carriers:

- In the past 10 years the use of solid biofuels fluctuated between 40 and 45 PJ. Most is used in residential applications, varying between 23 and 28 PJ. Another 10 PJ is used in industry. There has been a slight, but steady increase of solid biomass use for heat and power production, up to a level of 8 PJ recently.
- Renewable municipal waste increased to a level of 22 PJ in 2005. Its levels have stabilized recently around 24 PJ.
- Liquid biofuels were introduced around 2005 but stayed at modest levels of less than 1 PJ up to 2014. Since 2015 there has been a strong growth, reaching almost 8 PJ in 2019.

- Biogas was already quite relevant in the 2000s at a level of 2.5 PJ. Its share has more than doubled in the past decade to 5.6 PJ.

Table 3 displays the 2019 total bioenergy supply values on a per capita basis. Compared to the other 24 member countries of IEA Bioenergy (expressed per capita), Switzerland ranks very high for renewable MSW, in the middle for biogas and liquid biofuels and at the lower end for solid biofuels.

Table 3: Total energy supply per capita in 2019 for different bioenergy carriers

	Supply per capita	Median IEA Bioenergy members
Bioenergy	9.5 GJ/cap	10.6
Solid biofuels	5.1 GJ/cap	7.0
Renewable MSW	2.9 GJ/cap	0.8
Biogas	0.6 GJ/cap	0.7
Liquid biofuels	0.9 GJ/cap	1.5

Source: IEA (2021) World Energy Balances and Renewables Information

Table 4 indicates the amounts of the different bioenergy carriers compared to some relevant reference points, namely the amount of forest in the country (for solid biomass), the amount of generated MSW (for renewable MSW used for energy), the amount of natural gas consumed in the country (for biogas) and the amount of fossil oil products consumed (for liquid biofuels).

Table 4: Comparison of the supply of different bioenergy carriers in 2019 to specific reference points

	Compared to reference points		Median*
Bioenergy	8.0 %	of total energy supply	7.2 %
Solid biofuels	14.6 GJ/ha_forest	compared to the domestic hectares of forest land (excl. protected)	21.3 GJ/ha_forest
Renewable MSW	4.05 GJ/ton_MSW	compared to the total generated MSW in the country	1.4 GJ/ton_MSW
Biogas	0.045 GJ/GJ_NG	compared to natural gas supply	0.023 GJ/GJ_NG
Liquid biofuels	0.021 GJ/GJ_oil	compared to oil products supply	0.028 GJ/GJ_oil

Source: energy data from IEA (2021) World Energy Balances and Renewables Information; forest figures from FAOStat; waste figures from World Bank

* Median of the 25 member countries of IEA Bioenergy⁵

Specific comments in relation to the reference points:

⁵ Comparative figures of the different IEA Bioenergy member countries are discussed in the central Countries' Report.

- The use of solid biofuels compared to the domestic forest area is modest (<1 ton_dry mass of wood per hectare⁶) and there is room for increased mobilization.
- The use of renewable MSW for energy production is quite high, even when compared to other European countries with well-developed waste management systems.
- Biogas is also fairly well developed and represents a relevant share of gas supply. Mind that the overall role of natural gas in the Swiss energy system is fairly modest compared to some other countries.

ROLE OF BIOENERGY IN DIFFERENT SECTORS

OVERVIEW

The overall 2019 share of renewables in **final energy consumption** among electricity, transportation and heat sectors is almost 28%, with bioenergy making up 8.5% of the energy share (Table 5). Note that these figures are higher than the shares in total energy supply (where unused waste heat, e.g., in nuclear power production, is also included).

Table 5: Role of bioenergy and renewable energy in electricity, transport energy and fuel/heat consumption in 2019

Sector	Share of bioenergy	Share of renewable energy	Overall consumption
Electricity ⁷	2.9%	65.7% (59.2% hydro)	64 TWh (231 PJ)
Transport energy (final consumption)	3.2%	6.0%	238 PJ
Overall fuel and heat consumption ⁸	Direct biomass: 12.7% Biobased heat: 3.1%	16.7%	307 PJ
TOTAL FINAL ENERGY CONSUMPTION	8.5%	27.7%	759 PJ

Source: IEA (2021) World Energy Balances and Renewables Information

The following paragraphs will consider the evolutions in the different sectors.

⁶ Counted with a typical calorific value of wood (dry mass) of 19 GJ/ton_{dry mass}

⁷ Renewable electricity compared to final consumption. Potential renewable shares of imported electricity are not included.

⁸ This includes final consumption of fuels and heat in industry, the residential sector, commercial and public services and agriculture/forestry. Transport fuels are excluded. Energy used for transformation and for own use of energy producing industries is also excluded.

Electric heating (direct or through heat pumps) is not included in these figures as this is not separately reported.

ELECTRICITY

The Swiss power production is dominated by hydropower and nuclear power, providing around 55% and 37% of Swiss electricity generation, respectively. Between 2015 and 2017 there was a slight drop, both in nuclear and hydropower, leading to temporary imports of electricity (up to 9% of domestic consumption in 2017). In 2019 there was again a surplus of power, whereby 9% of domestic power production was exported.

In 2011, Switzerland decided to phase out nuclear power. In May 2017, Swiss voters accepted a new energy Act that aims to promote renewable energy by banning new nuclear power plants. The Mühleberg nuclear power station (355 MW) was permanently switched off on 19 December 2019. This is the first of five Swiss nuclear power reactors to be decommissioned.

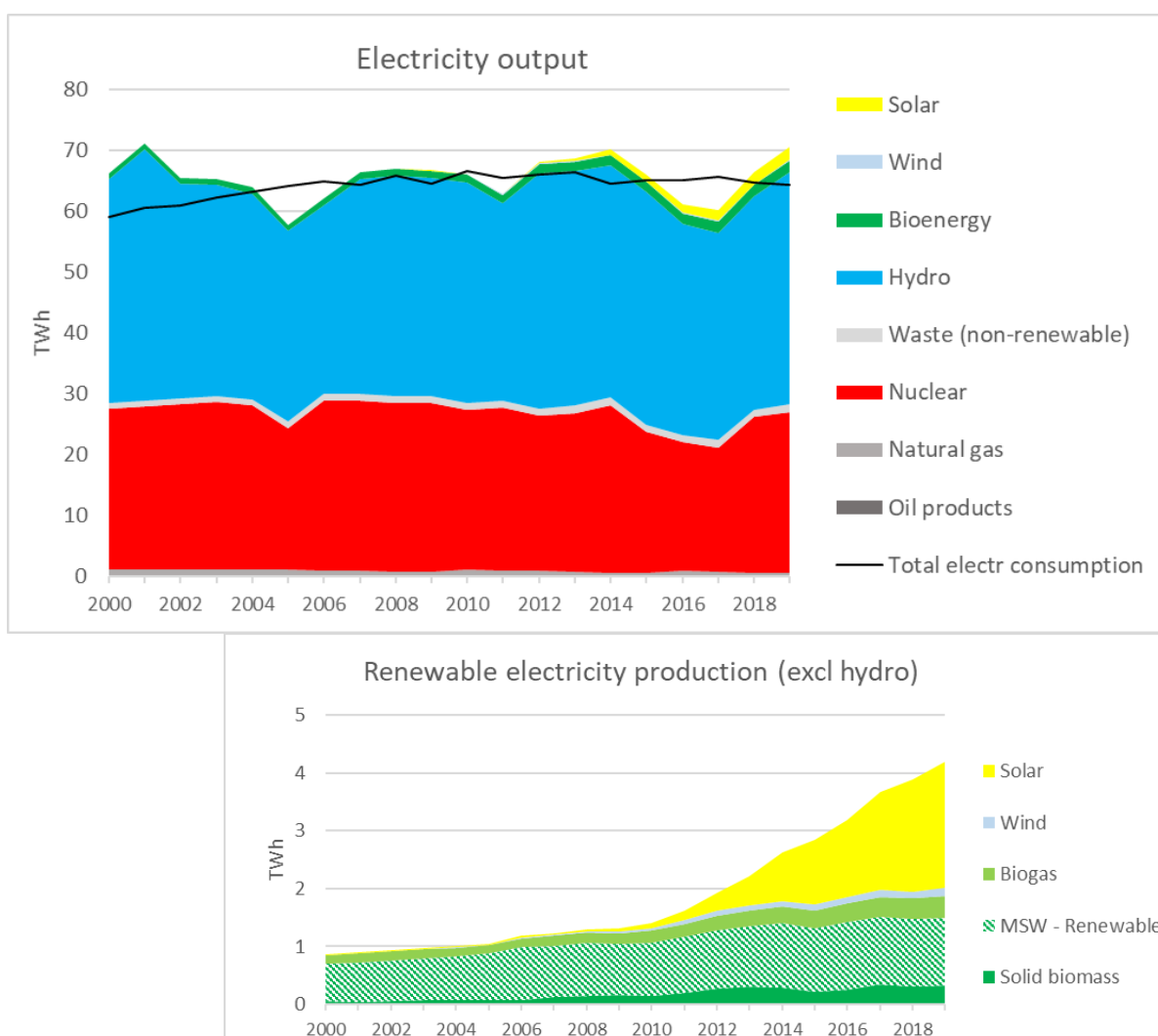


Figure 4: Evolution of the electricity mix in Switzerland 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)

The role of bioenergy in electricity is fairly modest, but still slightly growing, reaching 3% of electricity consumption in 2019. It is predominantly based on renewable MSW (in CHPs). Solar power had a strong growth since 2010 and now represents more than 3% of domestic electricity consumption in Switzerland. Wind power is still at very low levels (~0.2%).

Policy framework

The main relevant policy instruments behind these evolutions:

- Since 2008, the feed-in tariff policy called “Cost-covering remuneration for feed-in to the electricity grid”. The measure is limited to the end of 2022 according to the energy law. After this date, no new projects will be integrated into the feed-in system.
- Since 2018, waste incineration plants, sewage treatment plants, and wood power plants are no longer eligible for the feed-in system but can receive Investment contributions for electricity production.
- After 2022, the feed-in tariff policy should be replaced by Investment contributions for all renewable energies. A revision of the energy law has already been announced.

HEAT/FUEL

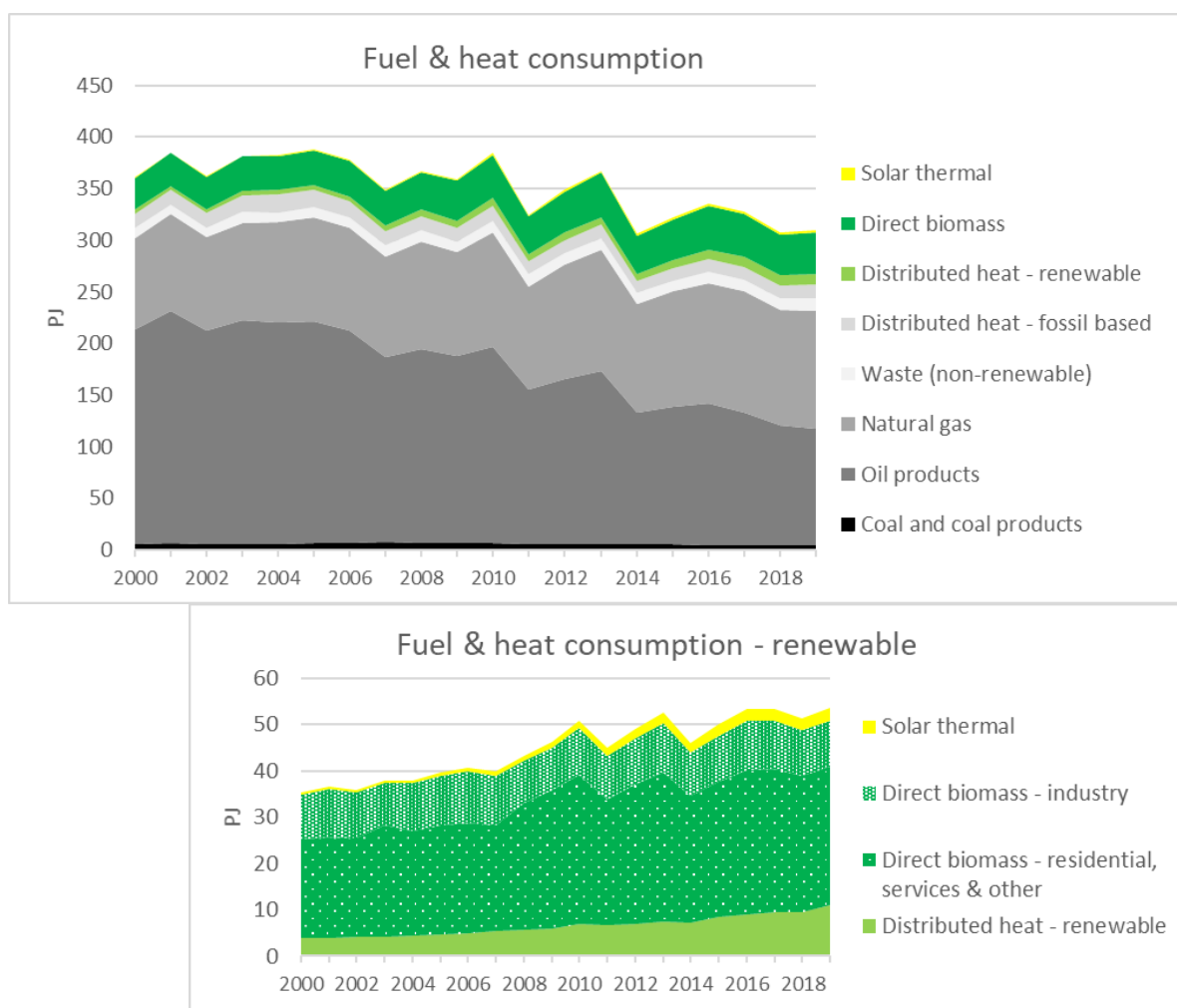


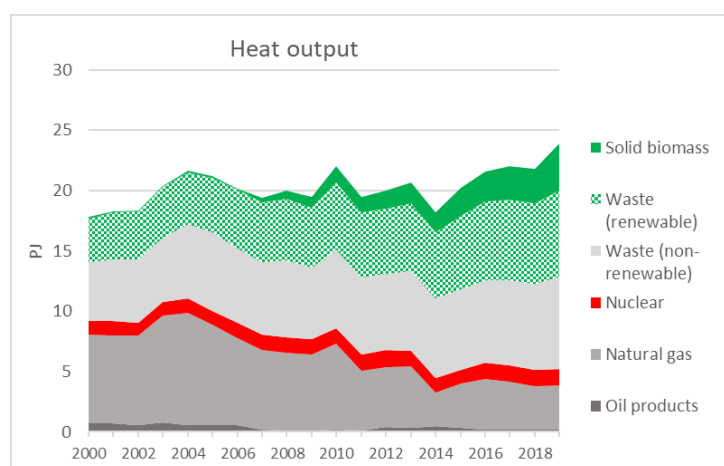
Figure 5: Evolution of fuel and heat consumption in Switzerland 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)

Figure 5 shows the role of different fuels/energy carriers for providing heat in different sectors (industry, residential sector, commercial and public services and other). It also includes heat sold to customers, e.g., through district heating. Fuel use by energy producing industries for transformation and for own use is excluded. Mind that electric heating (direct or through heat pumps) is not included in these figures as this is not separately reported.

Overall heat and fuel consumption in Switzerland is steadily decreasing, with some variations depending on the winter conditions. Fuel and heat consumption is still mostly (for 75%) based on fossil fuels. While consumption of oil products has steadily declined from 190 PJ in 2010 to 113 PJ in 2019, the amount of natural gas use remained stable around 115 PJ. Direct use of biomass is around 40 PJ, which is 13% of overall heat and fuel consumption. About half of this biomass is used in residential applications, a quarter in industry and a quarter in offices and public buildings.

Heat output generated and sold by CHP plants and heat plants represents around 7% of fuel/heat provided. As shown in Figure 6, only 16% is produced from fossil fuels (mainly natural gas). Around two thirds of distributed heat is produced from waste (which is around half biobased); another 16% is produced from solid biomass. Some residual heat from nuclear power is also used for heat distribution.

Figure 6: Evolution of fuels for heat output in Switzerland 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)



Policy framework

The main relevant policy instruments behind these evolutions:

- Since 2010, the Swiss federal and cantonal buildings programme has been promoting the energy-efficient renovation of buildings as well as renewable energies, waste heat recovery and the optimisation of building service technology.
- The CO₂ levy is imposed on all fossil thermal fuels (e.g., heating oil, natural gas). Since 2018 it has been set at CHF 96 per tonne of CO₂.

TRANSPORT

Figure 7 shows an overview of the energy used in transport in Switzerland, split up by different fuels/energy carriers.

While gasoline used to be the dominant transport fuel in Switzerland at more than 70% of overall transport energy consumption in 2000, its share has steadily dropped to 42% in recent years, while diesel continued to grow. Diesel consumption (fossil diesel and biodiesel) is now higher than gasoline at 51% of transport energy consumption.

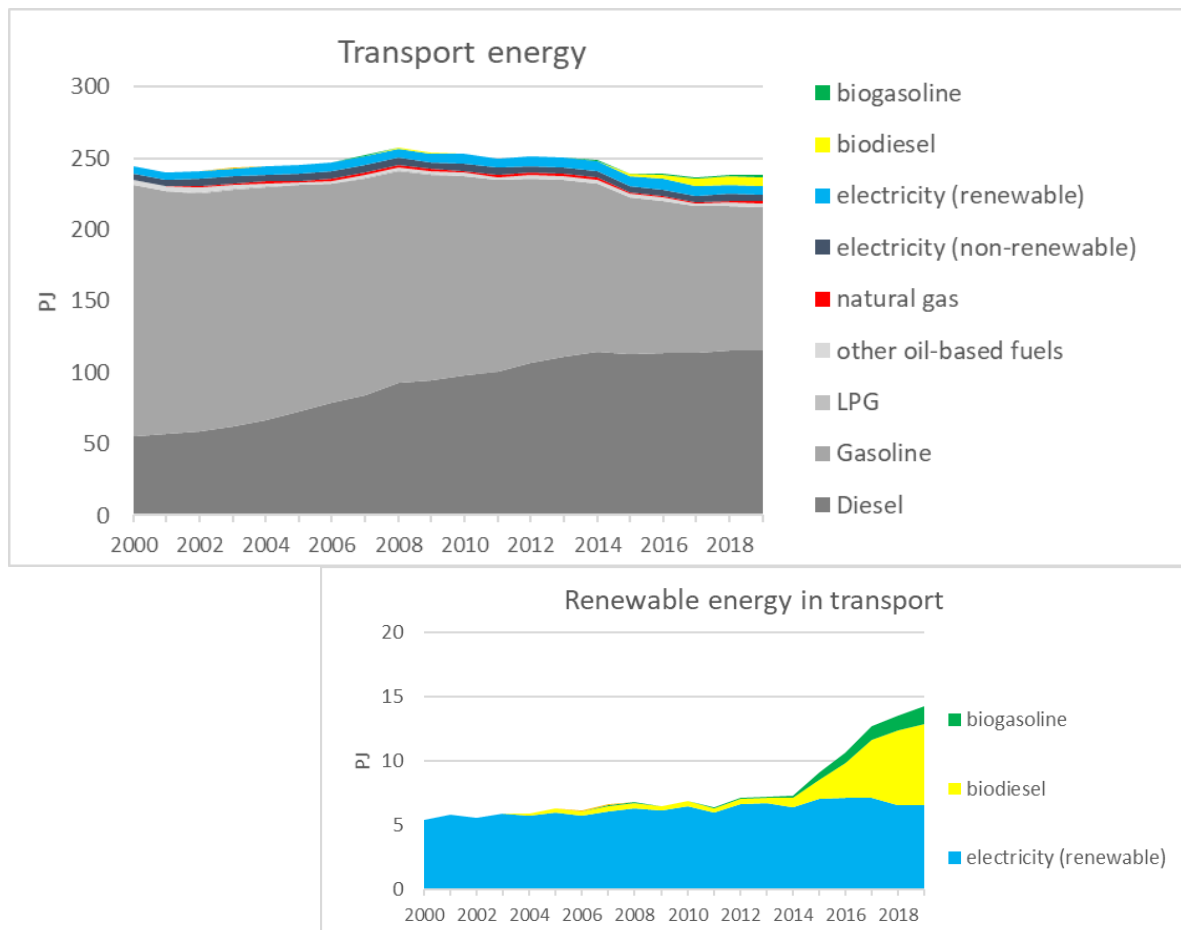


Figure 7: Evolution of transport fuels in Switzerland 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)

Around 2005, liquid biofuels were introduced, but these were still at very low level (<1PJ) up to 2014. Since 2015 there has been a strong increase of biofuels – particularly biodiesel – up to an overall level of 3.2% of transport energy consumption in 2019. Biodiesel represented on average 5% by energy of diesel consumption in 2019, while bioethanol only represented 1.2% by energy of gasoline consumption.

Electricity (which is 2/3 renewable) represents a relevant and stable share of 4.6% of total transport energy use in Switzerland. This is mostly in rail. Despite a strong annual increase of electric vehicle sales (2016, +42%; 2017, +36%, and 2018, +32%, 2019, + 50 %), the share of the total car fleet is still very small (28,716 passenger cars represent 0.5% of the total) [5].

Policy framework

The main relevant policy instruments behind the biofuel evolutions:

- Mineral oil tax and exemption for fuels with a renewable origin (limited to the end of 2023)
- CO₂-emissions compensation for motor fuels (compensation projects/acquisition of certificates or blending of fossil fuels with biofuels)

RESEARCH FOCUS RELATED TO BIOENERGY

The “Bioenergy” research programme of the Swiss Federal Office of Energy [6] supports innovative and relevant themes for Switzerland in the production of energy from biomass. The programme coordinates application-oriented research at the national level, exploits synergies and secures international networking. Central questions for the future concern which biomass proportions are used with which technologies and for which products in order to make a substantial contribution to the Swiss energy system while achieving a high level of efficiency. The system concept is becoming increasingly relevant, for example in relation to energy-storage issues, interaction with other energy technologies and bioeconomy concepts. In this context the increasingly cascading use of biomass and the circular economy is of central importance. In addition to the integration of bioenergy facilities in the overall energy system, ongoing technical innovation and optimisation of already existing technologies are important for making more efficient transformation processes available for the market.

Research priorities for 2021 to 2024

Biomass as substrate

Procurement of biomass, logistics (mobilisation, innovative logistics); new biomass substrate; biogenic waste (material and energy recycling).

Biomass for electricity and heat supply and as fuel

Production of process heat; innovative concepts for combining cogeneration plants with biogenic energy sources; optimal design configurations of district heat networks; small-scale biogas production for decentralised-use concepts; biofuels as “drop-in” fuels.

Biomass in the bioeconomy

Integration of materials recycling to generate material and energy added value (e.g., use of residual materials); energy aspects in the production of bio-based platform chemicals (efficiency, energy optimisation, integration, life-cycle assessment, etc.); higher added value of bioenergy facilities (new concepts, products).

LINKS TO SOURCES OF INFORMATION

- [1] Swiss Federal Office of Energy: <https://www.bfe.admin.ch>
- [2] IEA Policies Database: <https://www.iea.org/policies?country=Switzerland>
- [3] Energy Strategy 2050: <https://www.bfe.admin.ch/bfe/en/home/policy/energy-strategy-2050.html>
- [4]: Federal Office for the Environment FOEN – Climate: <https://www.bafu.admin.ch/bafu/en/home/topics/climate.html>
- [5] Federal Statistics Office: <https://www.bfs.admin.ch/bfs/de/home/statistiken/kataloge-datenbanken/publikationen.assetdetail.13695226.html>
- [6] Swiss Federal Office of Energy - Bioenergy” research programme: <https://www.bfe.admin.ch/bfe/en/home/research-and-cleantech/research-programmes/bioenergy.html>