ENERGY STRATEGY 2050
MONITORING REPORT
2019 ABRIDGED VERSION

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Federal Office of Energy SFOE

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INTRODUCTION

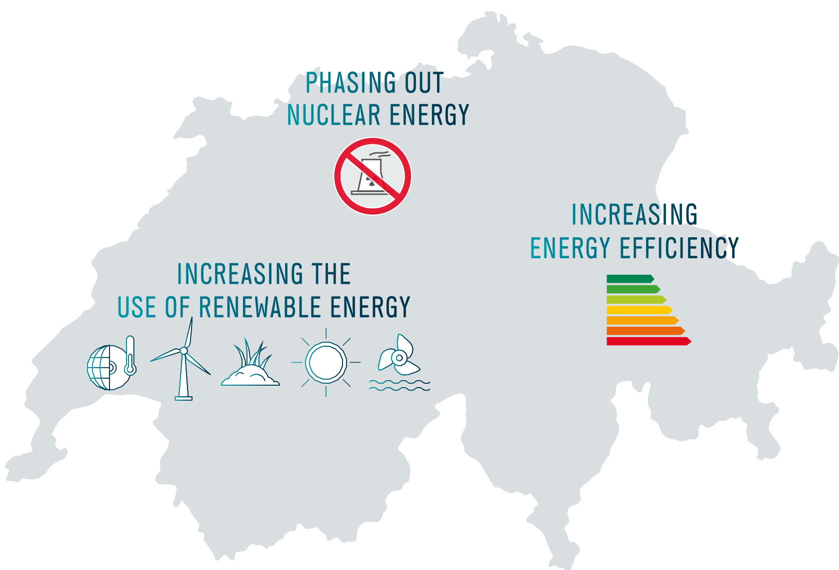
Switzerland has reorganised its national energy policy as a result of the adoption of Energy Strategy 2050. The energy strategy should facilitate the gradual phasing out of nuclear energy and the successive reorganisation of the Swiss energy system by 2050. The entire process will take place while maintaining the high degree of security of supply and Switzerland's reasonable prices for energy. The intention is to significantly increase energy efficiency and the share of renewable energy used in the energy mix as well as reduce CO_2 emissions from energy sources. In addition, no further general licences for the construction of nuclear power plants may be issued (Federal Council, 2013).

Continued ▸ ▸ ▸

In the referendum of 21 May 2017 Swiss voters accepted the new energy legislation, which entered into force at the beginning of 2018. In addition, on 27 September 2019 the Federal Council expressed its determination to fully liberalise the electricity market which should ensure that innovative products, services and the process of digitalisation will penetrate the market more rapidly. At the same time the Federal Council decided to present a revised Energy Act, which will increase the incentive to invest in domestic renewable energies (Federal Council, 2019c +2018). In view of the fact that about three quarters of the greenhouse gas emissions in Switzerland are caused through using fossil energy carriers, the energy strategy is closely linked to climate policy. Here the focus is on the next stage with the complete revision of the CO_2 Act (Federal Council, 2017), which is currently being debated in Parliament and which involves national implementation of the Paris Convention by 2030. As a signatory Switzerland has undertaken to half its greenhouse gas emissions in comparison to emissions in 1990 by this point in time. On the basis of new scientific findings issued by the Intergovernmental Panel on Climate Change (IPCC), on 28 August 2019 the Federal Council also decided that by 2050 Switzerland should not emit more greenhouse gases than can be absorbed naturally or by technical means (this means that net emissions will be reduced to zero by 2050); simultaneously the administration was asked to draft a corresponding long-term climate strategy for 2050 (Federal Council, 2019b).

The reorganisation of the Swiss energy system needed for Energy Strategy 2050 is a long-term project. The monitoring system operated by the Swiss Federal Office of Energy SFOE, the State Secretariat for Economic Affairs (SECO), and other federal offices observes significant developments and

Source: SFOE/heyday



↗ www.energystrategy2050.ch

progress, measures the degree to which significant targets are attained, and studies the economic cost and benefit from measures. This makes it possible to intervene early and to steer events based on facts if undesirable developments are observed. The legal bases for the monitoring procedure are provided in the energy legislation and in particular Art. 55ff of the Energy Act (EnG) and Art. 69ff of the Energy Ordinance (EnV). Article 74a of the Nuclear Energy Act (KEG) is also relevant to reporting about the development of nuclear technology.

The current Monitoring Report for 2018 (abridged version, most data stem from before and up to 2017), deals first with selected indicators and contains a descriptive part containing the seven topics mentioned below derived from Energy Strategy 2050, the Energy Act and other State bills (which include the Electricity Grid Strategy, climate policy, and Swiss Coordinated Energy Research):

TOPIC	**ENERGY CONSUMPTION AND PRODUCTION**
TOPIC	**GRID DEVELOPMENT**
TOPIC	**SECURITY OF SUPPLY**
TOPIC	**EXPENDITURE AND PRICES**
TOPIC	**CO_2 EMISSIONS FROM ENERGY SOURCES**
TOPIC	**RESEARCH AND TECHNOLOGY**
TOPIC	**INTERNATIONAL ENVIRONMENT**

Further indicators can be found in the full version of the Monitoring Report (see **www.energymonitoring.ch**).

In addition, the Federal Council will pre-papare a report for the attention of Parliament every five years containing in-depth analyses of further problems and topics thus facilitating a review of energy policy.

ENERGY CONSUMPTION AND PRODUCTION

Reduction of energy and electricity consumption by enhancing efficiency measures is one of the main objectives of Energy Strategy 2050 and therefore an important pillar of energy legislation. The same applies to the expansion of electricity production from renewable sources, which will have to partially compensate for the gradual loss of capacity from nuclear power plants. The indicators for this topic are in the main the predefined guidelines in the Energy Act for per capita energy and electricity consumption by 2020 and 2035, as well as the guidelines for the expansion of electricity production from renewable energies by 2020 and 2035, and for hydropower by 2035.

FINAL ENERGY CONSUMPTION PER PERSON AND YEAR

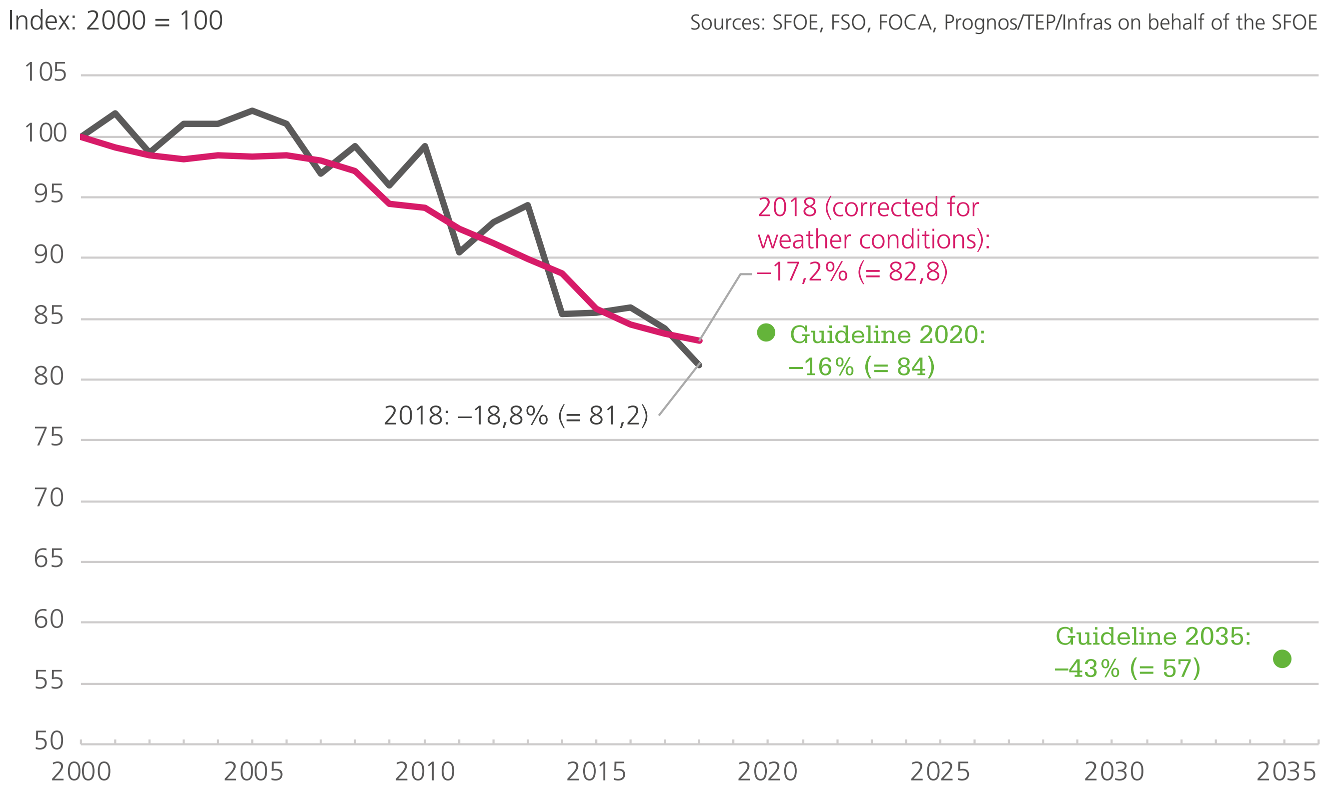


Figure 1: Development of per capita final energy consumption[1] since 2000 (indexed)

The per capita final energy consumption has fallen since 2000, as indicated in **figure 1**. The decline is a consequence of the lower absolute energy consumption in 2018 (-1.9 percent) compared to 2000 while at the same time the population increased by 18.5 percent. According to the Energy Act, the reduction target for 2020 is 16 percent in comparison to base year 2000, and 43 percent by 2035. In 2018 the per capita energy consumption was 87.4 gigajoules (0.025 GWh), and thus 18.8 percent lower than in 2000. When adjusted to take account of the weather the decline was 17.2 percent, thus undercutting the target for 2020 (*cf. red curve*). The per capita final energy consumption (adjusted to take account of the weather) will in future have to fall by 2.2 percent to ensure the guideline for 2035 can be attained. The fall in the absolute final energy consumption in 2018 compared to 2017 was in the main a consequence of the warmer weather which led to a corresponding decline in demand for space heating. Additionally, technical progress and political measures have also made a significant contribution to this decline in consumption. Over the entire period under consideration from 2000 to 2018, volume effects led to increased consumption; all 'pure' growth effects were counted, such as the overall economic output (excluding structural effects), population, energy consumption area, and the number of motor vehicles. Effects which tended to increase consumption were compensated by political measures and technological progress, which has increasingly had a dampening effect on consumption since 2000. Substitution of heating oil with gas and the increasing use of district heating plants, ambient heat and wood tended to reduce consumption between 2000 and 2018. In the fuels sector, the trend to substitute petrol with diesel fuel has been determined since 2016, but since then the effect of this change has become less significant (sources: SFOE; 2019a / FSO, 2019a / FOCA, 2019 / Prognos / TEP / Infras, 2019a+b).

1 Excluding international air traffic, excluding compressor gas consumption in the gas transit pipeline, excluding statistical difference and agriculture.

ELECTRICITY CONSUMPTION PER PERSON AND YEAR

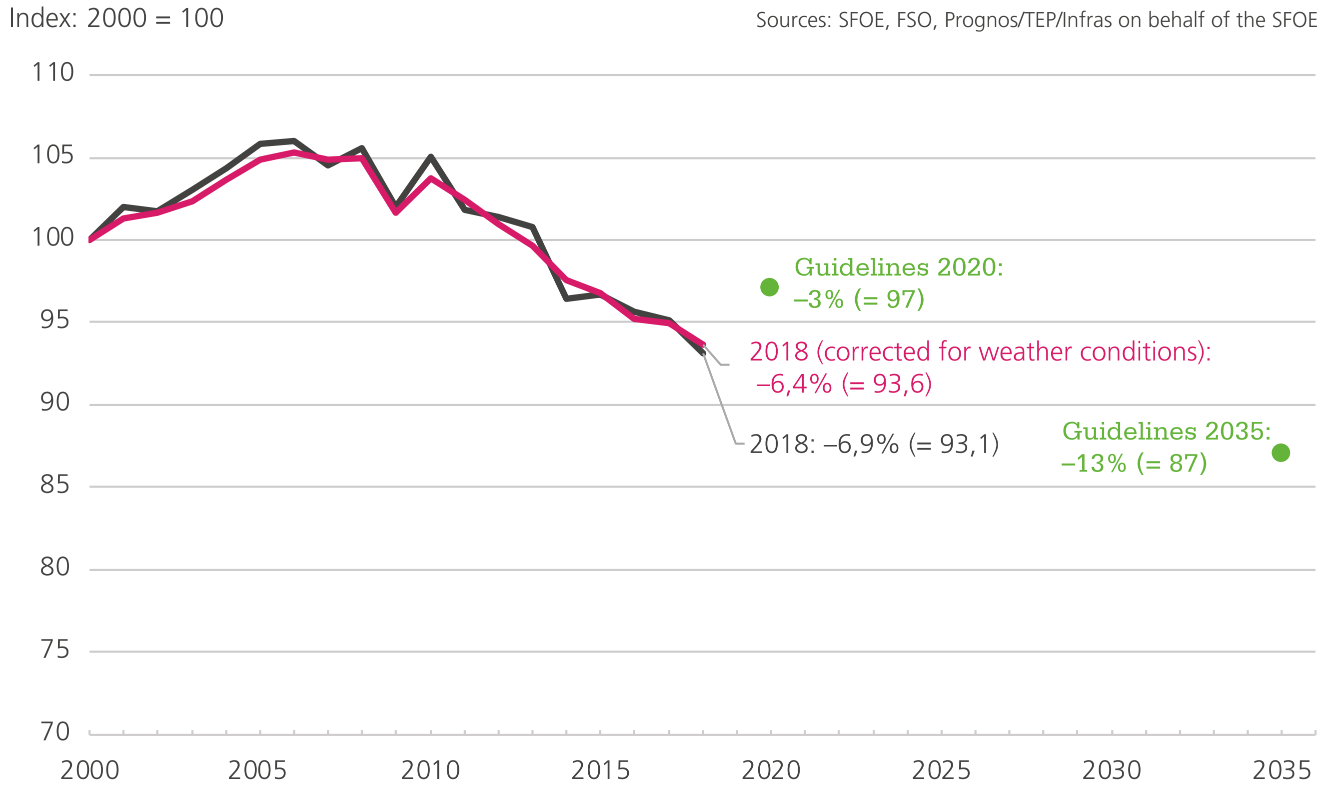


Figure 2: Development of per capita electricity consumption[2] since 2000 (indexed)

The per capita electricity consumption increased between 2000 and 2006 because the absolute electricity consumption rose by 10.3 percent while the population only increased by 4.2 percent. Since 2006 the trend has been reversed, as indicated in **figure 2**. Electricity consumption decreased by 0.1 percent between 2006 and 2018 while the population increased in the same time period by 13.8 percent. The major decline in per capita consumption in 2009 is a result of a clear cooling off in the economy. According to the Energy Act, the reduction guideline for per capita electricity consumption for 2020 is 3 percent in comparison to base year 2000, and 13 percent by 2035. In 2018 per capita electricity consumption was 24.0 gigajoules (0.007 GWh), and thus 6.9 percent less than in 2000. When adjusted to take account of the weather, the decline was 6.4 percent (*cf. red curve*) which means the guideline for 2020 has already been undercut. The per capita final electricity consumption (adjusted to take account of the weather) will in future have to decline by 0.4 percent to ensure the guideline for 2035 (-13%) can be attained. In 2018 the absolute electricity consumption decreased by 1.4 percent compared to 2017. The reasons for the decline were mainly technological progress and political measures. Further, the warmer weather had a tendency to slightly reduce electricity consumption. The long-term increase in electricity consumption during the entire monitoring period from 2000 to 2018 was mainly caused by volume effects and to a lesser degree structural effects (e.g., differing growth rates in individual branches of industry). Energy policy instruments and measures (e.g., political requirements and the voluntary measures from the SwissEnergy programme) and technological developments (construction measures such as insulation and use of more efficient heating plant, electrical devices, lighting, and machines, etc.) had the opposite effect and increasingly tended to reduce electricity consumption (sources: SFOE, 2019a/FSO, 2019a/Prognos/TEP/Infras, 2019a+b).

2 Excluding statistical difference and agriculture.

ELECTRICITY PRODUCTION FROM RENEWABLE ENERGIES (EXCLUDING HYDROPOWER)

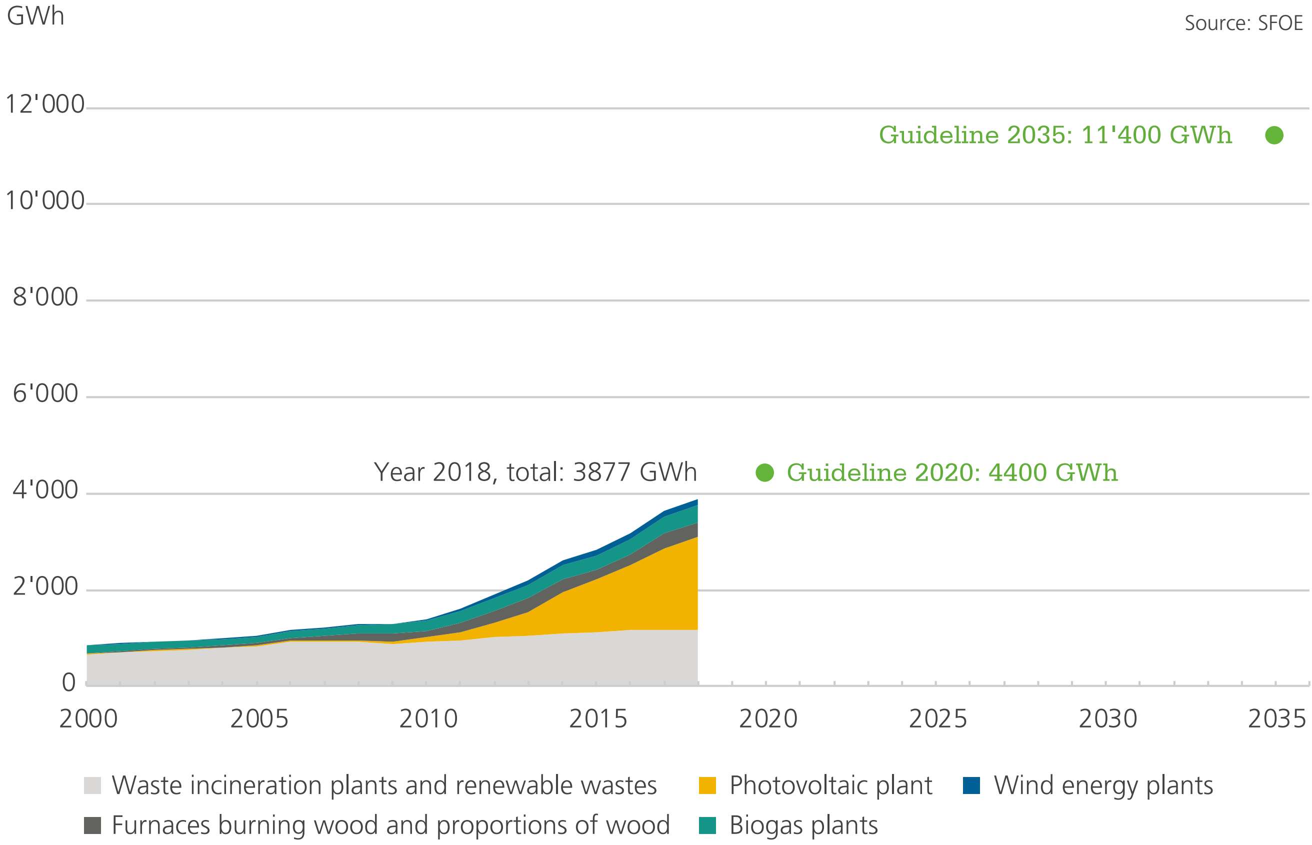


Figure 3: Development of electricity production from renewable energies (excluding hydropower) since 2000 (GWh)

Electricity production from renewable sources has increased since 2000, as indicated in **figure 3**. Production gained momentum from 2010 on. In 2018, 3,877 gigawatt-hours (GWh) were produced; this corresponds to 6.1 percent of the overall net electricity production (excluding consumption by storage pumps). In base year 2010 electricity production from renewables was 1,402 GWh. As a consequence, between 2010 and 2020 a net increase of about 3,000 GWh will be striven for. Of this increase about 82.6 percent had already been attained in the reporting year. In 2018 the net increase compared to 2017 was 224 GWh; since 2011 an average increase of 309 GWh per year has been attained. On average an annual net increase of 262 GWh will be required in the next few years to attain the guideline of 4,400 GWh in 2020. The guideline for 2035 is 11,400 GWh. To attain this a higher net increase of 443 GWh per year is required. When broken down according to technology, it is apparent that the photovoltaic sector has increased strongly in absolute terms since 2010. The photovoltaic sector contributes about 50.1 percent to electricity production from renewables. Electricity production from waste incineration plants and renewable wastes has also increased and along with the photovoltaic sector make the greatest contribution (30.2%) to electricity production from renewables. Electricity production from furnaces burning wood and proportions of wood increased too since 2010 (share 2018: 7.5%). The increase in electricity production from biogas was only slightly lower (share in 2018; 9.1%). And for its part wind energy has also increased since 2010, however, at 3.1 percent its share in electricity production from renewables is still small. No geothermal facilities for electricity production are being realised currently (source: SFOE, 2019a).

ELECTRICITY PRODUCTION FROM HYDROPOWER

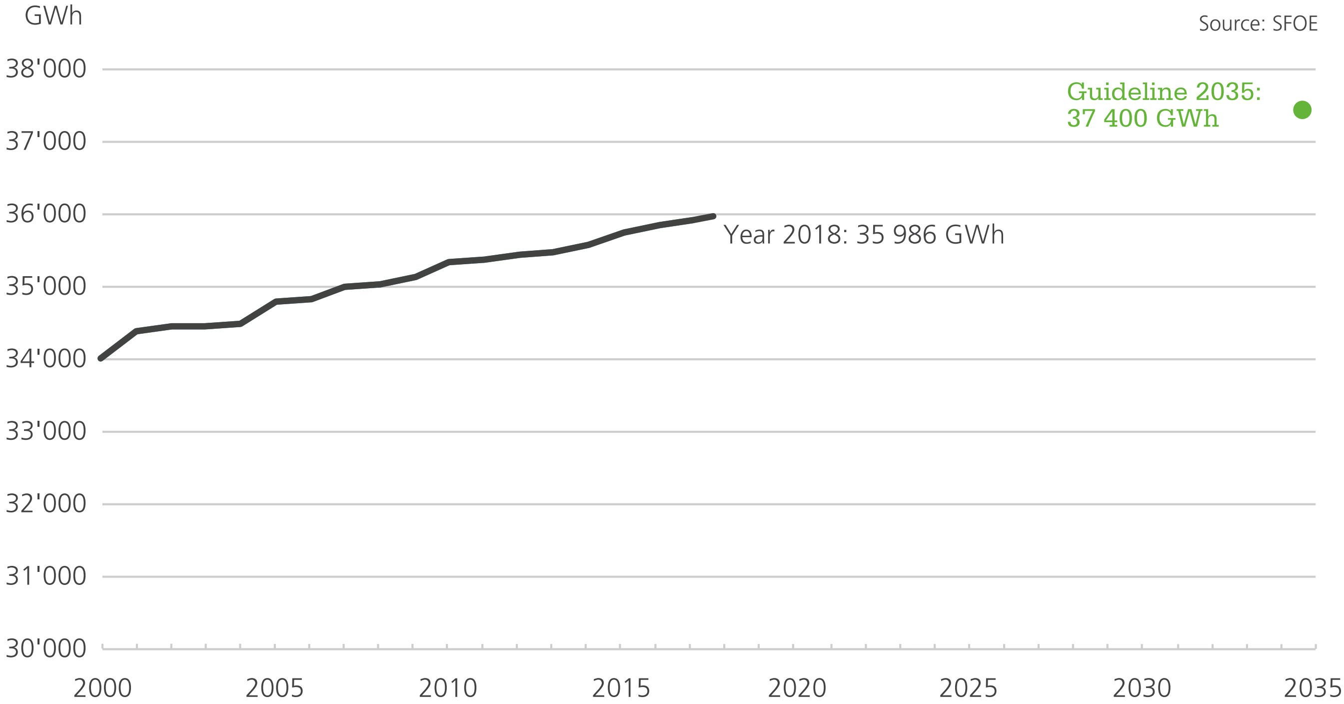


Figure 4: Development of anticipated average production[3] of electricity from hydropower since 2000 (in GWh)

Figure 4 (N.B. scale does not begin at zero) shows that electricity production from hydropower has grown continuously since 2000; this growth is primarily due to the addition of new facilities and expansion and optimisation of existing facilities. In 2018 (as at 1 January 2019) the anticipated average production was 35,986 GWh. In base year 2011 (as at 1 January 2012) the figure was 35,354 GWh. To achieve the guideline between 2011 and 2035 a net increase of about 2,000 GWh will be striven for. In the reporting year about 30.9 percent of this increase had already been attained. In 2018 the net increase compared to 2016 was 107 GWh; since 2012 this has been on average 90 GWh per year. To achieve the guideline by 2035, an average annual net increase of 83 GWh will be required over the coming years. According to the SFOE assessment (updated in 2019) concerning the potential for expansion of use of hydropower, from today's standpoint this guideline is indeed attainable, however to do this the entire potential for expansion available would have to be realised by 2050; what was not taken into consideration in the analysis is the potential from new glacial lakes or the potential from projects which the electricity industry has not declared on grounds of confidentiality (sources: SFOE, 2019b+e).

3 Anticipated average production including anticipated production from small power plants <300 kW (according to statistics for hydropower plant in Switzerland, WASTA). Excluding average energy required for all storage system pumps (an efficiency rate of 83% is assumed) and excluding electricity required for recirculation.

↗ More detailed indicators to the topic
ENERGY CONSUMPTION AND PRODUCTION
(See the detailed version of
the Monitoring Report)

GRID DEVELOPMENT

The reorganisation of the energy system required in connection with Energy Strategy 2050 and the new international environment place new demands on the energy grid. Development of the electricity grid is crucial because it is the link between production and consumption. Grid development is also the focus of the legislation on the Federal Act on the Transformation and Extension of the Electricity Grid (Electricity Grid Strategy), which is part of the energy strategy, but was handled in a separate bill (Federal Council, 2016). The focus of the monitoring programme is firstly on the electricity grid.

STATUS AND DURATION OF PLANS FOR THE TRANSMISSION GRID

Energy Strategy 2050 and the Electricity Grid Strategy create reliable conditions for a needs-based, targeted development of electricity grids to guarantee the security of the electricity supply. To this end the standards for assessing the need to expand and modernise Switzerland's electricity grid have been developed, the authorisation procedures for line projects optimised and the requirements for deciding whether to place cables underground or to use overhead transmission lines have been also elaborated. The intention of the new regulations is to increase transparency in the grid planning process and improve acceptance for grid plans in general. The focus will be on the Swiss transmission grid: It will have to guarantee the transmission of energy fed in from domestic production centres as well as imported energy over long distances to centres of consumption in a satisfactory and safe way. In addition the grid will have to compensate for fluctuating rates of energy fed in from renewable energies through imports and exports as well as cope with the complementary characteristics of various types of power plant.

PROCEDURE AND PHASES OF A GRID PLAN IN THE TRANSMISSION GRID

Preliminary project: As the basis for the sectoral plan procedure, the national grid company Swissgrid draws up a preliminary project with the key parameters of the grid plan and makes sure the concerns of the cantons affected by the project are considered as early as possible in the planning stage. For the purposes of the monitoring programme the preliminary project phase begins simply with the start of the project and ends when the application is submitted for the plan to be incorporated in the sectoral plan for transmission lines (German SÜL). If a plan is not yet in either the preliminary phase or construction project phase and thus in an early stage of planning, it is designated in the monitoring programme as a **project proposal**.

SÜL: If a grid transmission line project will have a substantial impact on the area and the environment, a sectoral plan procedure has to be carried out before the planning approval procedure begins (see below). The SÜL applies to the electrical power line sector. The Swiss Federal Office of Energy (SFOE) is responsible for the SÜL procedure and receives support from the Federal Office for Spatial Development (ARE). In the first stage of the sectoral plan procedure a **planning area** is determined and in the second stage a **planning corridor** is selected for the path of the transmission line. At the same time as the planning corridor is determined, a decision is made as to which **transmission technology** will be employed (overhead transmission line or underground cable). The SÜL phase begins when Swissgrid submits an application for an SÜL procedure and ends when the decision is taken on the planning corridor by the Federal Council in the appropriate coordination plan. This plan is binding on all authorities, which means they have to take it into consideration when approving the plan and in any other spatial development activities.

Construction project: Once the planning corridor has been determined, Swissgrid's grid plan is elaborated in a concrete construction project. The compa-

In April 2015, the national grid company Swissgrid submitted a strategic grid plan[4] which took into consideration the gradual phasing out of nuclear power in accordance with Energy Strategy 2050 including suitable projects to upgrade and expand the transmission grid by 2025. The current monitoring process will follow the status and duration of grid plans at transmission grid level including Swissgrid's Strategic Grid 2025 plan as well as other important projects. The focus will be on the transmission line projects mentioned in **figure 5**.

4 vgl. www.swissgrid.ch / netz2025

ny has to guarantee that the line will be built using the transmission technology determined and that the line route lies within the planning corridor that has been laid down. In the current monitoring procedure the construction project phase begins with the determination of the planning corridor (corresponds to the end of the SÜL phase). In projects for which no SÜL is employed, the start of the construction project is as laid down in the appropriate SIA standard.

Planning approval procedure (German PGV): Swissgrid now submits the elaborated construction project (detailed project) together with the application for planning approval to the Federal Inspectorate for Heavy Current Installations (ESTI). This signals the start of the planning approval procedure (PGV). ESTI is responsible for checking the dossier and for issuing planning approval. During the PGV checks are made to ensure compliance with safety regulations and legal stipulations, in particular environmental and spatial planning legislation. Additionally, checks are made of the grid plan to ensure conformity with the interests of private persons (landowners, neighbours). If ESTI is unable to resolve all the objections or cannot handle all the differences with the various state authorities concerned, the dossier is entrusted to the SFOE. The SFOE then proceeds with the planning approval procedure and issues planning approval provided the grid plan is in conformity with the legal requirements. A decision is also made on any other objections (for example objections to compulsory purchase). The parties involved can appeal to the Federal Administrative Court (BVGer) and thereafter in certain cases to the Federal Tribunal (BGer). If the SFOE approves the application for planning approval and no other objections are submitted within the legal deadlines, planning approval becomes final and Swissgrid can realise the transmission line project.

Realisation: For monitoring purposes the start of the realisation phase is counted as the date of the legally valid decision on planning approval. The realisation phases ends when the grid plan goes into operation.

GRID PROJECT	DESCRIPTION AND MAIN AIMS	CURRENT STATUS[5]	PLANNED OPERATION[6]
1. Chamoson–Chippis	▪ New 30 km long 380 kV overhead transmission line between Chamoson and Chippis ▪ Dismantling of almost 89 km of power lines in the Rhone plain ▪ Transfer production from hydropower plants in Valais ▪ Improved connection between Valais and the Swiss and European high tension grid ▪ Contribution to grid security in Switzerland	Realisation	2021
2. Bickigen–Chippis (Gemmi line)	▪ Modernisation of substations at Bickigen and Chippis and of the existing 106 km route by increasing current to 380 kV ▪ Installation of a 220/380 kV grid coupling transformer in the Chippis switchgear facility ▪ Improved transfer of electricity production from Valais ▪ Contribution to security of supply	PGV SFOE	2027
3. Pradella–La Punt	▪ Increase voltage from 220 to 380 kV on existing 50 km route ▪ Modification of switchgear at Pradella and increase of voltage to 380 kV ▪ Elimination of existing bottleneck ▪ Contribution to Swiss and European grid security	Realisation	2022
4. Chippis–Lavorgo 4.1. Chippis–Mörel 4.2. Mörel–Ulrichen (Gommer line) 4.3. Chippis–Stalden 4.4. Airolo–Lavorgo	▪ Increase voltage to 380 kV on 124 km Chippis-Mörel-Lavorgo axis (Chippis-Stalden remains at 220 kV) ▪ Dismantling of existing lines over 67 km ▪ Supplements the main supply route for Ticino ▪ Elimination of a critical supply bottleneck	4.1. PGV ESTI 4.2. Realisation (Mörel–Ernen)/In operation (Ernen–Ulrichen) 4.3. PGV SFOE (Agarn–Stalden)/PGV ESTI (Chippis–Agarn) 4.4. Construction project	2029
5. Beznau–Mettlen 5.1. Beznau–Birr 5.2. Birr–Niederwil 5.3. Niederwil–Obfelden 5.4. Obfelden–Mettlen	▪ Optimisation of existing route over 40 km by increasing current to 380 kV and upgrading on a stretch of 24 km ▪ Elimination of a structural bottleneck ▪ Creation of the conditions needed to combine domestic hydropower plants with fluctuating energy from wind and photovoltaic plant to respond to demand	5.1. Realisation 5.2. Preliminary project 5.3. SÜL 5.4. Preliminary project	2027

Figure 5: Overview of grid projects, status and proposed date of operation (as at 15.10.2019)

5 As at 15 October 2019

6 According to Swissgrid planning

GRID PROJECT	DESCRIPTION AND MAIN AIMS	CURRENT STATUS[5]	PLANNED OPERATION[6]
6. Bassecourt–Mühleberg	▪ Upgrading of the existing line over a length of 45 km by increasing the voltage level to 380 kV because decommissioning Mühleberg nuclear power plant will lead to withdrawal of some feed-in at the 220 kV grid level ▪ Contribution to Swiss grid security and security of supply	BVGer	2027
7. Magadino	▪ Installation of transformers between the 220 kV and 380 kV grids ▪ The aim is to improve the transfer of energy generated in Maggiatal by hydropower ▪ Contribution to security of supply in Ticino	Project idea	2035
8. Génissiat–Foretaille	▪ Upgrading of (replacement of cable) the existing 220 kV twin lines over a length of 17 km ▪ Eliminates frequent bottlenecks which occur for imports from France	In operation	Concluded in 2018 and in operation
9. Mettlen–Ulrichen 9.1. Mettlen–Innertkirchen 9.2. Innertkirchen–Ulrichen (Grimsel line)	▪ Upgrade the existing 220 kV line over 88 km to cope with a future increase to 380 kV ▪ Important for the connection of new pump storage power plants to the 380 kV grid and transfer of energy to the rest of Switzerland	Preliminary project	2035
10. All'Acqua-Vallemaggia-Magadino	▪ New 220 kV line through the Valle Maggia ▪ Existing line built in the 1960s will be dismantled – thus lessening the impact on the protected areas in Upper Ticino ▪ Increase of grid capacity to convey energy generated in hydropower plants in Valle Maggia ▪ Greater security of supply in the sounthern Alps – today production at power plants has to be curbed	SÜL	2035
Connection of Nant de Drance NdD_1 Le Verney/Rosel–Bâtiaz NdD_2 Bâtiaz–Châtelard NdD_3 Châtelard–Nant de Drance	▪ Connection of pump storage power plant Nant de Drance to the high tension grid ▪ Part of the strategic grid in the Swissgrid initial grid ▪ Contribution to integrate new renewable energy sources	NdD_1 Realisation NdD_2 in operation NdD_3 Realisation/partly operational	2017–2019
ASR (Axe Stratégique Réseau) in the Geneva area	▪ Underground cabling of existing 220 kV line from Foretaille-Verbois over a length of about 4.5 km alongside Geneva airport	Realisation	2022

Figure 5: Overview of grid projects, status and proposed date of operation (as at 15.10.2019)

5 As at 15 October 2019

6 According to Swissgrid planning

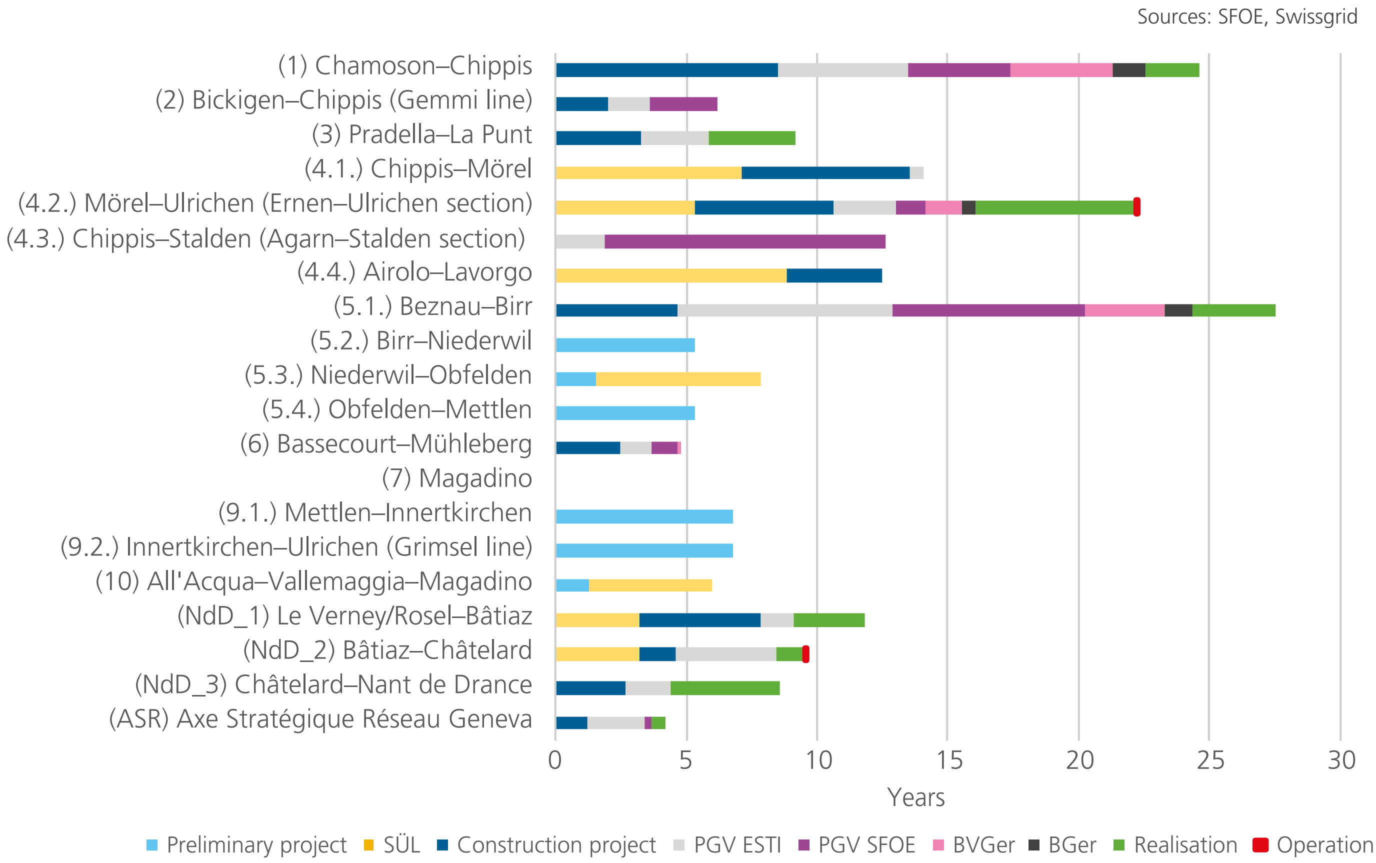


Figure 6: Accumulated duration of project phases of selected grid plans in years on grid level 1 as at 15 October 2019[7]

Figure 6 presents the duration of each individual project phase for the grid projects listed above. The duration is presented in a simplified manner in that any supplementary loops in the course of the project (that is if the procedure is returned to the SFOE after a decision by the Federal Administrative Court and / or the Federal Tribunal) are not shown separately. If specific project phases have to be gone through again as a result of a court decision, the overall duration of single project phases is presented as if each was unique and proceeded linearly. The figure corresponds to the initial position as it appears according to current legislation. No statement is implied as to whether or not Energy Strategy 2050 and the Electricity Grid Strategy will be able to further optimise the procedures as anticipated at present, because most of the corresponding legislation only took force in June 2019. The new stipulations are intended to optimise and streamline the authorisation procedures.

7 ***Remarks on the method used:*** *a) In the case of grid plans with a long preliminary period the duration was calculated from the relaunch of the project concerned; b) in the case of plans with a long preliminary period, it is not always possible to establish the preliminary project phase and the construction project phase, which is why they are not shown in the figure in some cases; c) assumptions were made in agreement with Swissgrid about some dates which are no longer known; d) when the courts refer a PGV decision to the SFOE, half of the supplementary duration of the procedure is allotted to the PGV phase and half to the construction project phase.*

BRIEF DESCRIPTION OF EACH GRID PLAN (AS AT 15 OCTOBER 2019):

1. Chamoson–Chippis

Construction of the new line from Chamoson to Chippis in the Canton of Valais was initiated before the transmission grid sectoral plan (SÜL) was elaborated and the project was the subject of planning and authorisation phases for many years. An important milestone was reached in 2017: in its decision of 1 September 2017 the Federal Tribunal dismissed the appeals against the decision of the Federal Administrative Court of 14 December 2016 and confirmed the PGV decision of the SFOE of 19 January 2015. Thereafter Swissgrid proceeded with the realisation of the new overhead transmission line project. As before there is still strong resistance to the project among the population. Two former appellants each entered an appeal and a petition to grant the appeal suspensive effect to the Federal Tribunal, however the Federal Tribunal rejected the request for suspensive effect in October 2018 and the appeal was rejected at the end of January 2019. Operation of the line is planned for 2021.

2. Bickigen–Chippis

The SÜL procedure could be dispensed with for the project to increase the voltage and modernise the existing line between Bickigen and Chippis because the project only had a modest effect on the area. After a construction project phase of about two years, the PGV procedure started with an application to ESTI in mid-2015, and almost two years later the dossier was passed on to the SFOE. The PGV is currently pending at the SFOE. Operation of the line is planned for 2027.

3. Pradella–La Punt

As part of the project to increase grid capacity a second continuous 380-kV circuit will be added to the 50 km line between Pradella and La Punt. The transfer of energy on the existing 220-kV overhead transmission line between Zernez and Pradella from the Ova Spin power plant will be substituted by a 380-kV circuit. The energy generated at Ova Spin power plant will be transported over a new 110-kV valley cable, which still has to be constructed. No SÜL procedure was necessary because of the minimal effect on the area. The construction project and PGV phases each lasted about three years. The project has been in the process of realisation since mid-2016 because there was no opposition to the ESTI planning approval procedure. The line should go into operation in 2022.

4. Chippis–Lavorgo

Operation of the entire Chippis-Lavorgo grid plan project is planned for 2024. The project consists of a number of sub-projects the current status of which is shown here:

4.1. Chippis–Mörel

The plan for the construction of the new line underwent an SÜL procedure lasting almost seven years and the construction project took almost six and a half years: the PGV was submitted to ESTI at the end of March 2019.

4.2. Mörel–Ulrichen

The plan for the construction of the new line was subject to a planning and authorisation procedure lasting many years; the section between Ernen and Ulrichen has gone into operation mid-October 2019; in the section Mörel-Ernen the Federal Tribunal ordered that a study on the use of a cable should be made for the 'Binnegga–Binnachra–Hockmatta–Hofstatt' area (crossing the Binna) and this has been submitted to the SFOE; the SFOE approved the overhead line version on 23 December 2016 and turned down all objections. Objections to the decision were submitted to the Federal Administrative Court, which confirmed on 26 March 2019 that the overhead power line variant would be implemented. No appeal was lodged with the Federal Tribunal within the deadline so the decision is now in force. Construction of the line is planned for 2020.

4.3. Chippis–Stalden

The planning approval procedure for the Agarn–Stalden sector is being processed by the SFOE (procedure under former law, no SÜL procedure was carried out). However, in 2012, it was determined in the sectoral plan procedure for the line from Chippis–Mörel that the Chippis–Agarn section would have to be led through the planning corridor parallel to the Rhone Valley line. The PGV for the project has been submitted to ESTI.

4.4. Airolo–Lavorgo

The plan for the construction of the new line was subject to an SÜL procedure lasting almost nine years and the construction project has been under way for just over three and a half years.

5. Beznau–Mettlen

Operation of the overall Beznau–Mettlen grid project is planned for 2027. The project consists of a number of sub-projects the current status of which is shown here:

5.1. Beznau–Birr

The line with partial underground cabling of 'Gabihübel' at Riniken was initiated before the SÜL was elaborated and went through planning and authorisation phases lasting many years. An important milestone was reached in 2016: planning approval given by the SFOE became final so realisation of the project was initiated. Contrary to the original plan, construction work for the cable route could only begin in August 2018.

5.2. Birr–Niederwil

The line is currently in the preproject phase.

5.3. Niederwil–Obfelden

The project to increase the voltage level went through a preliminary project phase lasting about one and a half years and an SÜL procedure has been in progress for a number of years; a significant interim stage was reached in 2016 with the determination of the planning area.

5.4. Obfelden–Mettlen

The line is currently in the preproject phase.

6. Bassecourt–Mühleberg

The Bassecourt-Mühleberg high tension line was authorised by ESTI to operate at a voltage of 380 kV in 1978, however it has been operating at 220 kV up to now. No SÜL procedure was required for the envisaged increase in voltage because of the minimal effect the project would have on the area. After a construction project phase lasting about two and a half years, Swissgrid submitted the PGV dossier to ESTI on 30 June 2017. A number of objections to the project were submitted. ESTI handed the dossier over to the SFOE on 24 August 2018 and the plan was approved on 22 August 2019. A number of objectors have lodged appeals against this decision with the Federal Administrative Court. Operation of the line is planned for 2027 depending on the progress made with the current proceedings.

7. Magadino

The project is still in the early stages and has been submitted as a project proposal. According to Strategic Grid 2025 operation was originally foreseen for 2018, however, according to updated plans it is now proposed for 2035.

8. Génissiat–Foretaille

Swissgrid has adapted the scope of the project and reduced it to resolving the bottlenecks between France and Switzerland. The original plan to strengthen the Foretaille-Verbois line on the Swiss side has been abandoned. Additional cables on the French side of the Génissiat-Verbois line and the corresponding modification of protection for the line in Switzerland and France are sufficient in the opinion of Swissgrid; the bottleneck in France has been eliminated. The project was concluded in 2018 and the line is in operation.

9. Mettlen–Ulrichen

The plan, which includes the sections *Mettlen–Innertkirchen (9.1.)* and *Innertkirchen–Ulrichen (9.2., Grimsel line)*, has been the subject of a preliminary project to prepare the SÜL procedure for a number of years. According to Strategic Grid 2025 operation was planned for 2025 but 2035 is envisaged at present.

10. All'Acqua–Vallemaggia–Magadino

Planning of the line project in the All'Acqua–Maggiatal–Magadino area (and of subproject *4.4 Airolo-Lavorgo* mentioned above) is based on a comprehensive study carried out in 2013 concerning reorganisation of the high voltage grids in Upper Ticino to coordinate the refurbishment and modernisation of lines in coordination with spatial planning. Subsequently, the preproject phase was elaborated and the SÜL procedure commenced in 2015. In 2016 a significant stage in the project was attained when the planning area was defined. Currently, the SÜL procedure to determine the planning corridor is ongoing. Because of its size, the project was divided into sections that could be carried out in manageable stages. Operation of the 220-kV line is planned for 2035. Finally, the lines that are no longer need will be dismantled.

FURTHER SELECTED PROJECTS

Connection of the **Nant de Drance pump storage power plant** to the high tension grid contributes to integrating new renewable energies thus making it important with respect to Energy Strategy 2050. The project consists of three sub-projects. The first two sub-projects went through an SÜL procedure lasting about three years, followed by the construction project phase (almost five and one and a half years respectively) and the planning approval procedure (over one year and then almost four years). Both sub-projects were realised in 2016: the overhead line from Châtelard–La Bâtiaz was completed and became operational in 2017. The third sub-project has been under construction since July 2015 following on relatively quick construction project and PGV phases of two and a half and just under two years respectively (no SÜL procedure was necessary). The line has gone into operation in stages since 2018.

The Canton of Geneva, Geneva airport and a group of private investors are planning a number of urban development projects around the airport entitled **Axe Stratégique Réseaux (ASR)**. To realise these urban projects the existing 220 kV line will be laid underground simultaneously with the extension of the motorway and a building air-conditioning project led by SIG (Services Industriels de Genève) on a 4.5 km long stretch beside the motorway and the airport. The Canton of Geneva and the investors are financing the project. Planning approval was issued at the end of March 2019 by the SFOE (an SÜL procedure was not required) two and a half years after the application for planning approval had been submitted to ESTI. At present the plan is for the line to become operational at the end of 2022.

(Sources: SFOE / Swissgrid, 2019 / Swissgrid, 2015).

PLACING CABLES UNDERGROUND

Placing electricity cables underground can contribute to greater acceptance of line construction by the population meaning projects can be completed quicker. As a rule the quality of the countryside is improved and the risks of electrocution and of birds colliding with installations can be avoided. However, whether to construct a transmission grid cable (grid level 1) as an overhead line or place it underground has to be decided on the basis of objective criteria[8] on a case to case basis. According to the Federal Act on the Transformation and Extension of the Electricity Grid (Electricity Grid Strategy), distribution grid lines (grid levels 3, 5 and 7) should be placed underground provided a specific cost factor is not exceeded (cost overrun factor)[9]. For this reason development of the use of underground cable at distribution grid level is a subject of the monitoring process. This will also provide information about the impact of the cost overrun factor.

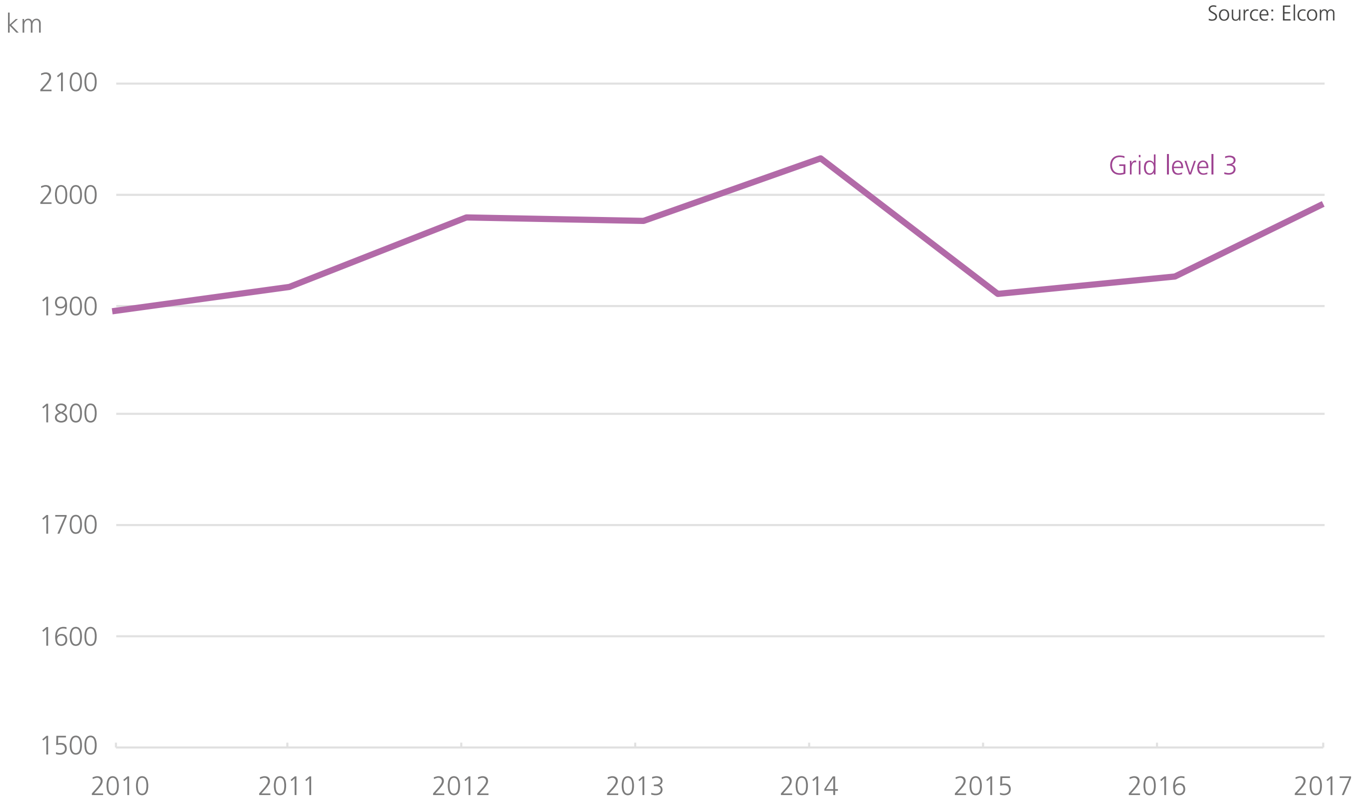
More cables have been placed underground at all grid levels of the distribution grid to varying extents since 2010, as indicated in **figure 7**. In general, there is more underground cable in use at lower grid levels; grid level 7 in particular consists almost entirely of underground cable. At grid level 5 cabling has advanced, in particular in urban areas. In contrast, only a slight increase in the number of underground lines can be observed at grid level 3, but to a lesser degree than at all other grid levels (*cf. purple curve in the upper graph with differing scale*). The trend toward underground cabling is not so pronounced at this level. In addition, between 2014 and 2015 a decline was observed the reasons for which are not clear. Overall, the three transmission grid levels (overhead transmission lines and cables including domestic connections) are 195,672 km in length, of which 87 percent consists of underground cable. Up to now very few transmission grid lines (6,590 km in length) have been laid underground (grid level 1); part of the Beznau-Birr grid project (*see above*) will be laid underground at 'Gäbihugel' near Bözberg / Riniken, where for the first time Swissgrid placed a longer section of a 380 kV high tension line (about 1.3 km) underground in an earlier project. A further underground cable project involving a transmission grid line is the replacement of the existing 220 kV line over a length of 4.5 kilometres in the ASR project in the Canton of Geneva (*see above*) (sources: ElCom, 2019 / SFOE / Swissgrid, 2019).

8 cf. SFOE evaluation scheme for transmission grid lines: www.bfe.admin.ch

9 The package of laws and by-laws for the Electricity Grid Strategy have been in force since 1 June 2019; the conditions for the cost overrun factor come into force only on 1 June 2020 to enable advanced projects to be completed under the current legal conditions.

↗ More detailed indicators on the topic of **GRID DEVELOPMENT** (See the detailed version of the Monitoring Report)

Source: Elcom



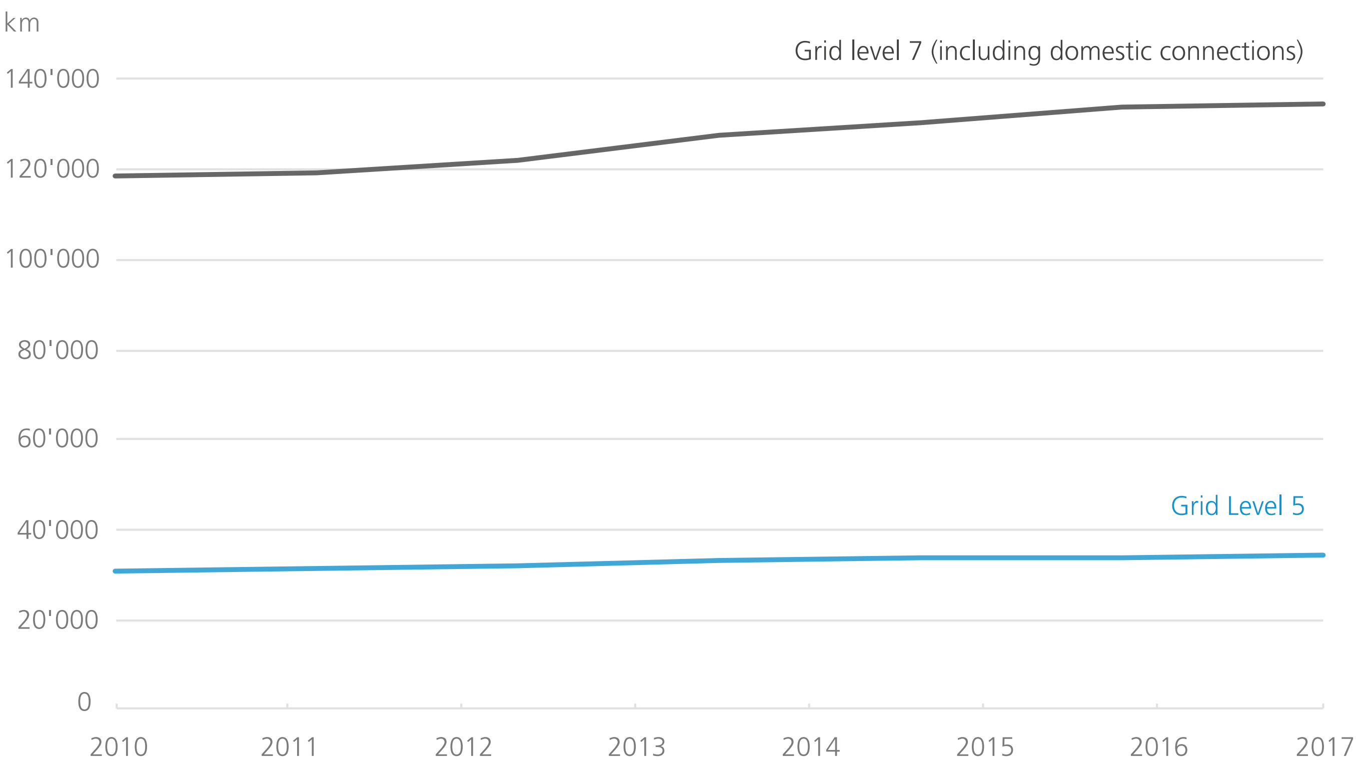


Figure 7: Inventory of cables in the distribution grid (in km)

SECURITY OF SUPPLY

One of the purposes of Energy Strategy 2050 is to guarantee the current high level of security of supply in the long term. The topic of security of supply is established in the energy article of the Federal Constitution and the Energy Act. By categorising energy carriers (diversification) and dependence on foreign supplies, the monitoring process observes indicators which characterise significant aspects of development in the field of security of supply from the overall energy perspective. With the phasing out of nuclear power, the expansion of use of renewable energies, increased energy efficiency, and the fairly long-term decarbonisation of the energy system, the electricity sector is also a centre of focus.

DIVERSIFICATION OF THE ENERGY SUPPLY

Figure 8 indicates that petroleum products (combustibles, vehicle fuel, including aircraft fuel in international traffic) constituted about half of the final energy consumption in 2018. Electricity accounted for about one quarter of the final energy consumption and gas accounted for about 14 percent of this energy. The share of petroleum products in the energy mix fell by 10 percent between 2000 and 2018 because of a reduction in the volume of petroleum combustibles used. The shares of gas (+2.5%), electricity (+3%), wood and charcoal (+1.3%), other renewable energies (+2.6%) and of district heating (+0.8%) have increased. In comparison to 2017, in 2018 the greatest deviations were observed in the segments petroleum combustibles (-1.1%), petroleum fuels (+1.3%), gas (-0.5%), and renewable energies (+0.3%). Overall the energy supply is broadly diversified, which contributes to the high degree of security of supply in Switzerland (source: SFOE, 2019a).

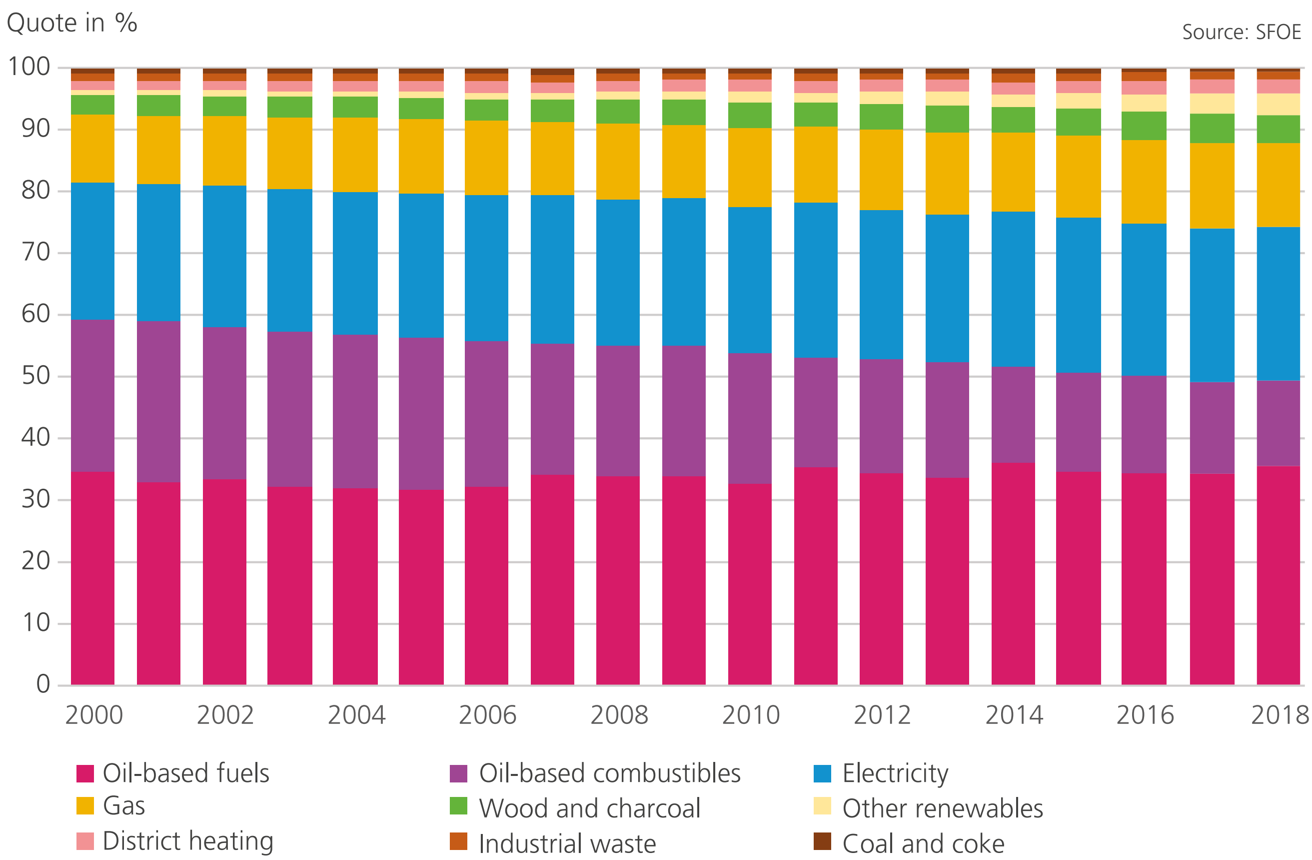


Figure 8: Diversification of the energy supply: share of energy carriers in final energy consumption

DEPENDENCY ON OTHER COUNTRIES

Figure 9 indicates that the import surplus tended to rise between 2000 and 2006, after which it fell, although one or two strong fluctuations were seen. At the same time the trend in domestic production has been toward increase since 2000. Gross imports were composed in the main of fossil energy carriers and nuclear fuel, that is energy from non-renewable sources. The most significant domestic energy source remains hydropower while the other renewable energies continue to grow. As indicated by the black curve in the graph, the share of imports in gross energy consumption (dependency on other countries) grew from 2000 to 2006 and has declined since then, however this share remains at a high level: in 2018 the share of imports in gross energy consumption was 75.0 percent (2017: 75.3% and 2016: 75.8%). This ratio has to be interpreted with caution because there are a number of different factors which influence it. In general it can be said that energy efficiency measures that lower consumption, and thus imports of fossil energy in particular, and the expansion of domestic energy production from renewable sources reduce dependency on other countries and have a positive effect on security of supply (sources: SFOE, 2019a/FSO/FOEN/ARE, 2019).

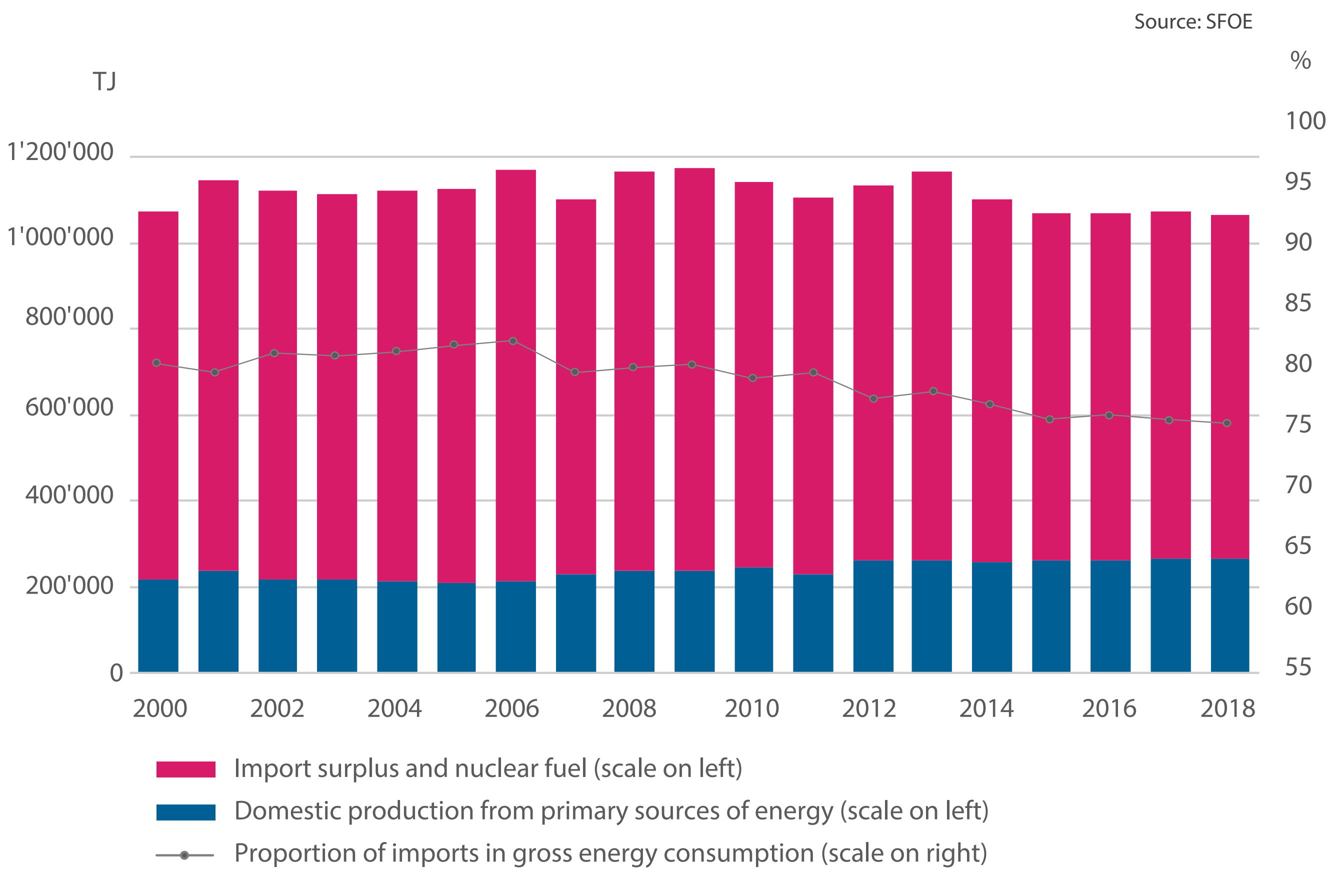


Figure 9: Import surplus and inland production (in TJ) and share of energy imports in gross energy consumption (in %)

SYSTEM ADEQUACY

Guaranteeing the **security of the electricity supply** in Switzerland is also based on the interplay between power plant capacity and the grid, which makes transmission and distribution of the energy produced possible. The grids supplement domestic power plant capacity and are equally important for ensuring security of supply. As a strongly networked country Switzerland is also dependent on the circumstances in neighbouring states. Close international cooperation is indispensable to the security of supply. However, because countries are rearranging their strategies (above all in the EU) the situation changes over time so periodic overall analyses of system adequacy are required to evaluate the security of supply. That means using an overall modelling approach for the security of supply situation which looks at the strategic direction taken in the sectors generation, consumption and the grid infrastructure required. In 2017, the ETH Zurich and the University of Basel conducted such a study on behalf of the SFOE for the first time concerning Switzerland for the period up to the year 2035; in 2019 the study was updated to encompass a further five year time span up to the year 2040. As in 2017, the study is based on a selection of energy scenarios concerning the development of demand and supply in Switzerland and Europe. The quantitative findings of the updated study are fundamentally consistent with those of the prior study dating from 2017: in the scenarios contemplated it was seen that even in the long term there was no security of supply situation that could not be controlled using operative measures implemented by the transmission grid operator Swissgrid. Even when a combined situation consisting of Germany phasing out the use of coal and France reducing its nuclear energy capacity at an early stage is studied, a good supply situation results overall for Switzerland in the various scenarios. This evaluation also applies for the time after nuclear power plants have been phased out in Switzerland. Consequently, it was also seen that increasingly the security of the electricity supply will be guaranteed by electricity imports. On the other hand Swiss hydropower plants benefit from changes in the production mix in EU countries in that they are more in demand during peak load periods in the EU. In view of the future implementation of the Paris Convention and Switzerland's more exacting long-term climate target (net zero greenhouse gas emissions by 2050) the updated study focused on strengthening electrification on the demand side. According to the initial indications (on the basis of a lack of consistent carbon reduction scenarios extending beyond the electricity sector and Switzerland, there are no final credible results) it seems that long-term demand for electricity will rise resulting in new challenges (sources: University of Basel / ETHZ, 2019 + 2017).

More detailed information on the topic of **SECURITY OF SUPPLY:**

- See the detailed version of the Monitoring Report
- SFOE report on system adequacy in Switzerland

EXPENDITURE AND PRICES

In addition to safety and environmental compatibility, a further significant dimension in a sustainable energy supply is economic viability. Energy article 89 of the Constitution and article 1 of the Energy Act determine the need to strive for a sufficient, diversified, safe, economic and environmentally compatible energy supply. The purpose of Energy Strategy 2050 is to successively reorganise Switzerland's energy systems without jeopardising the international competitiveness of Switzerland as a business location. Therefore the focus in this area is on final consumer expenditure for energy and energy prices.

FINAL CONSUMER EXPENDITURE FOR ENERGY

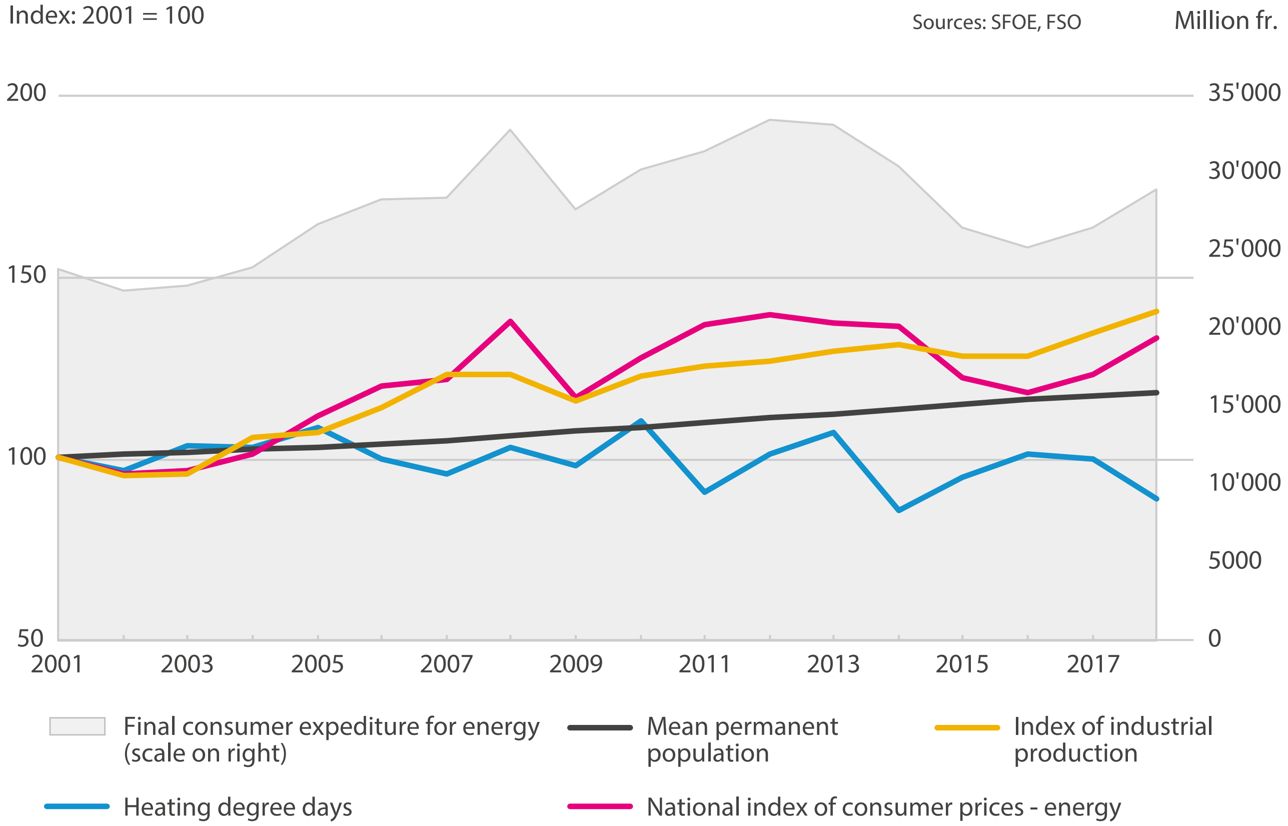


Figure 10: Final consumer expenditure for energy (in million francs) and significant influencing factors (indexed)

Figure 10 indicates the development of final consumer expenditure for energy in Switzerland, which has increased from 23.8 billion francs in 2001 to almost 28.9 billion francs in 2018. Over half of the expenditure was for petroleum products, one third for electricity, almost 10 percent for gas, and the remainder for solid combustibles and district heating. Between 2001 and 2018 this constituted an average increase of 1.1 percent per annum. During the same time period growth has been seen in industrial production (1.9% per annum), the population (0.9% per annum) and the Swiss consumer price index for energy (1.6% per annum). What is noticeable is the similarity between the progression of final consumer expenditure and the consumer price index for energy. Among other reasons, this is because energy prices have little influence on consumer behaviour in the short term because this behaviour depends more on other existing and comparatively constant factors, such as the number of vehicles and homes. This constitutes an example of low, short-term price elasticity. Further, in 2008, a significant increase in final consumer expenditure and energy prices can be seen, followed by a drop in the next year; this can be partially explained by the improvement in the economy and the slump that followed as a result of the financial and economic crisis. In 2018 final consumer expenditure rose slightly compared to 2017, when it also increased; this increase is attributable to slight price increases. Meanwhile, improved energy efficiency measures can put a damper on energy consumption and therefore on final consumer expenditure (sources: SFOE, 2019a/FSO, 2019a).

ENERGY PRICES FOR SECTORS OF INDUSTRY IN INTERNATIONAL COMPARISON

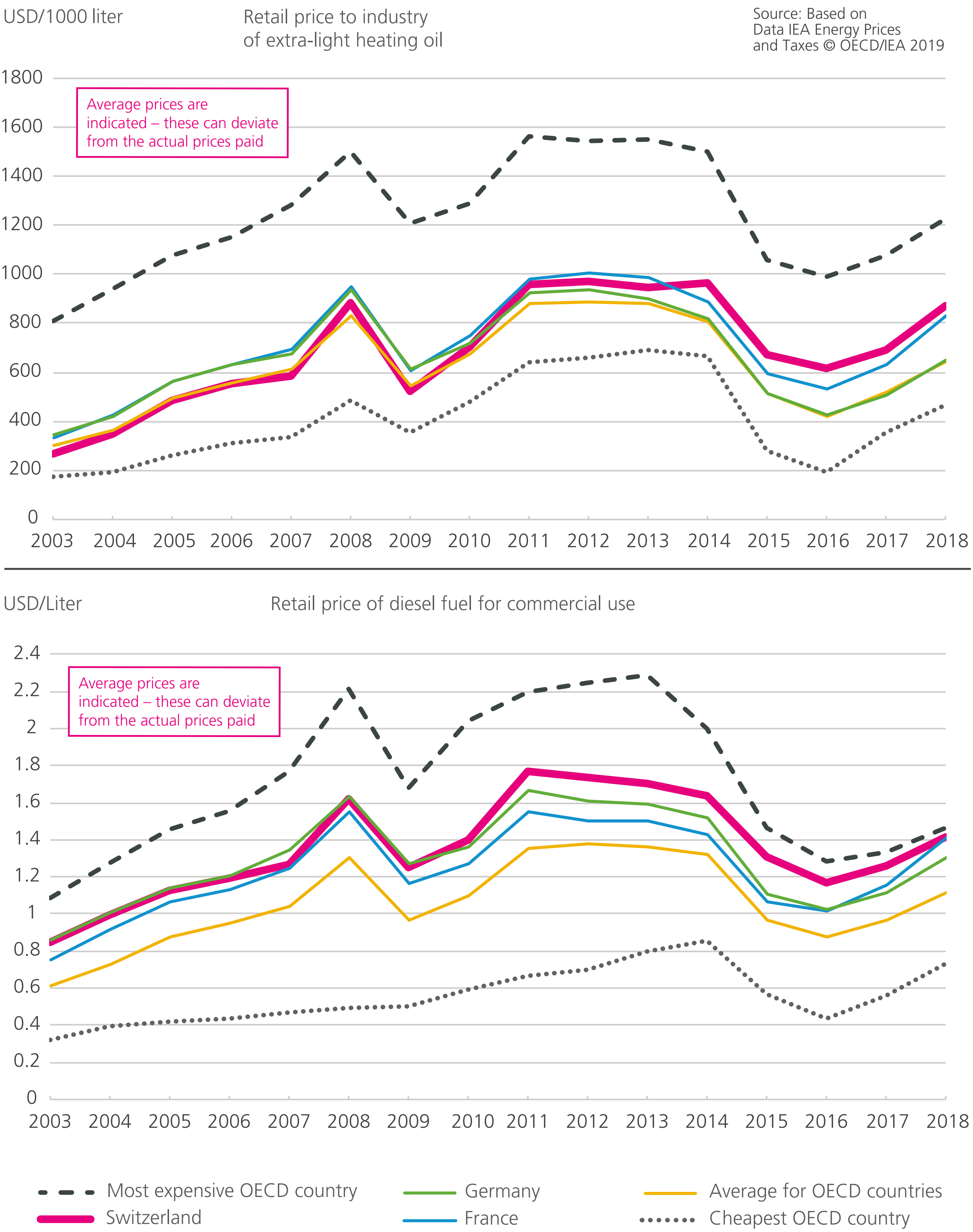
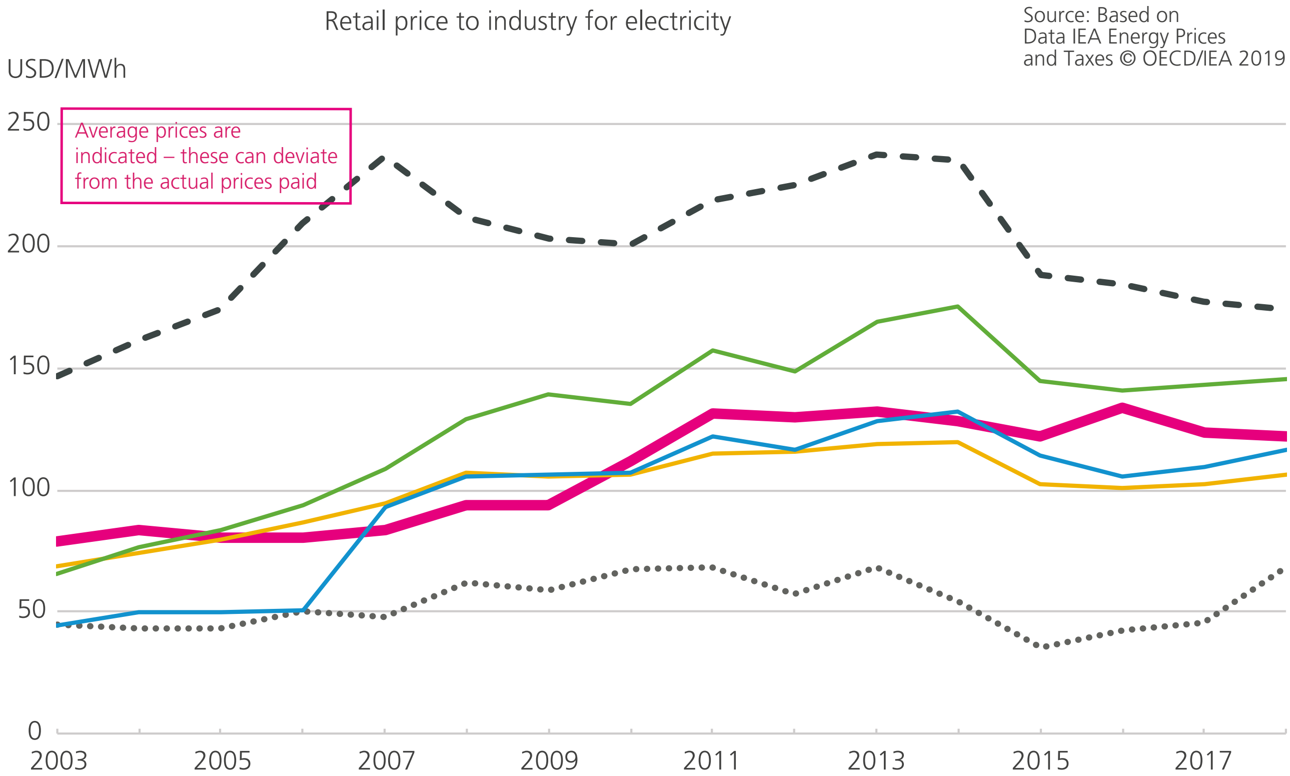


Figure 11: Average nominal end-user prices for heating oil and diesel fuel including taxes for the industrial sector in USD (calculated on the basis of market exchange rates)

Oil as a raw material and the energy carriers resulting from the refining process, such as **heating oil** and **diesel**, are traded on the global market. This partly explains the similar development of prices in most of the countries indicated in the graphic (**cf. figure 11**). In 2018 the price for Swiss heating oil was above the OECD average, and the prices increased in the OECD and in Switzerland. One explanation for the increase in Swiss prices for heating oil in relation to other countries could at least partly be the gradual increase in the CO_2 levy since it was introduced in 2008 from 12 to 96 francs per tonne of CO_2 in 2018; this increase was implemented because the interim biannual targets determined by the Federal Council for reduction of emissions from fossil combustibles were not attained. The price level for diesel in Switzerland is higher than in Germany or about average compared to OECD countries – the price in France rose in 2018 to a price similar to that in Switzerland. The picture for petrol as a vehicle fuel may differ because diesel is more heavily taxed in Switzerland than in other countries. Information about comparative international petrol prices is not monitored in the report because petrol is less significant to industry. The diesel price in Switzerland is significantly nearer to that in the most expensive rather than the cheapest OECD country (source: OECD/IEA, 2019a).

ENERGY PRICES FOR SECTORS OF INDUSTRY IN INTERNATIONAL COMPARISON



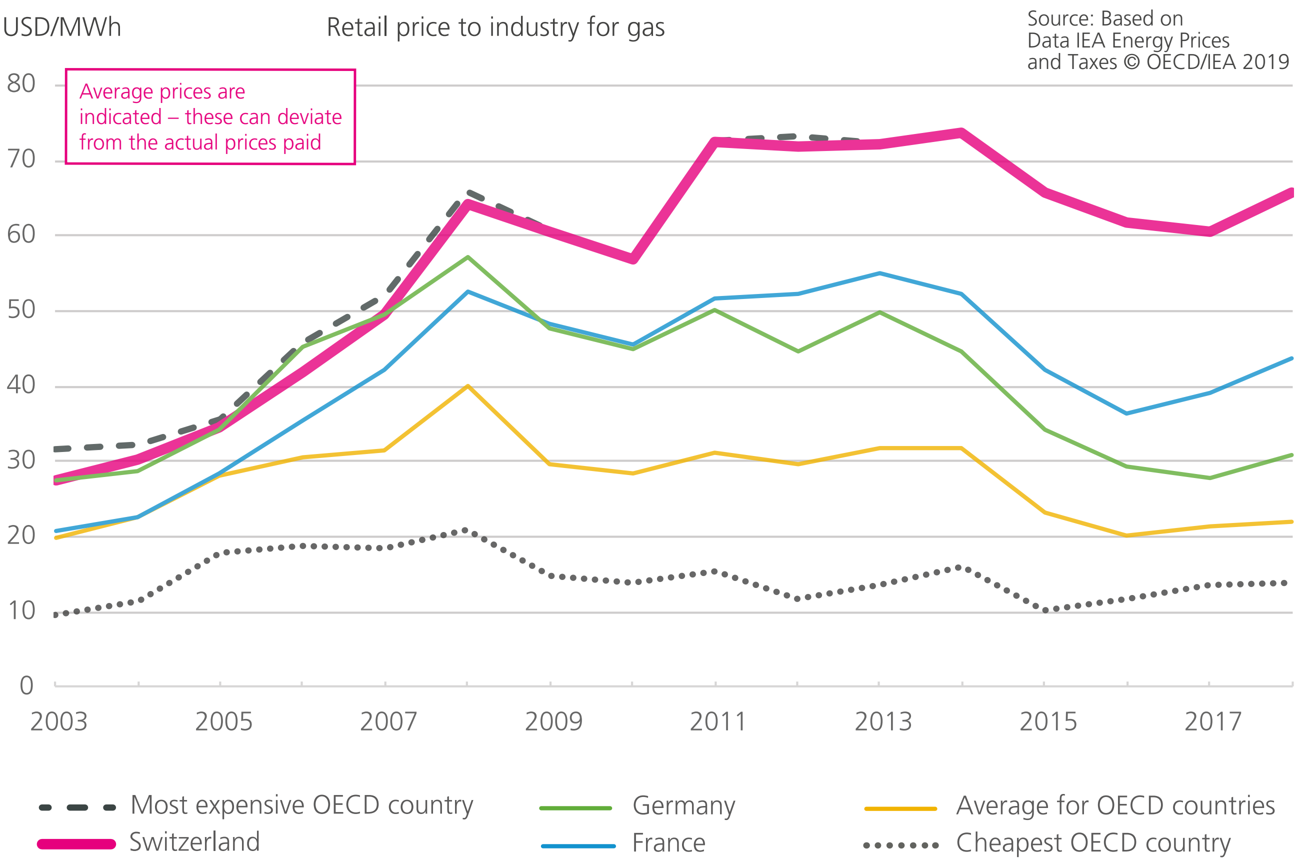
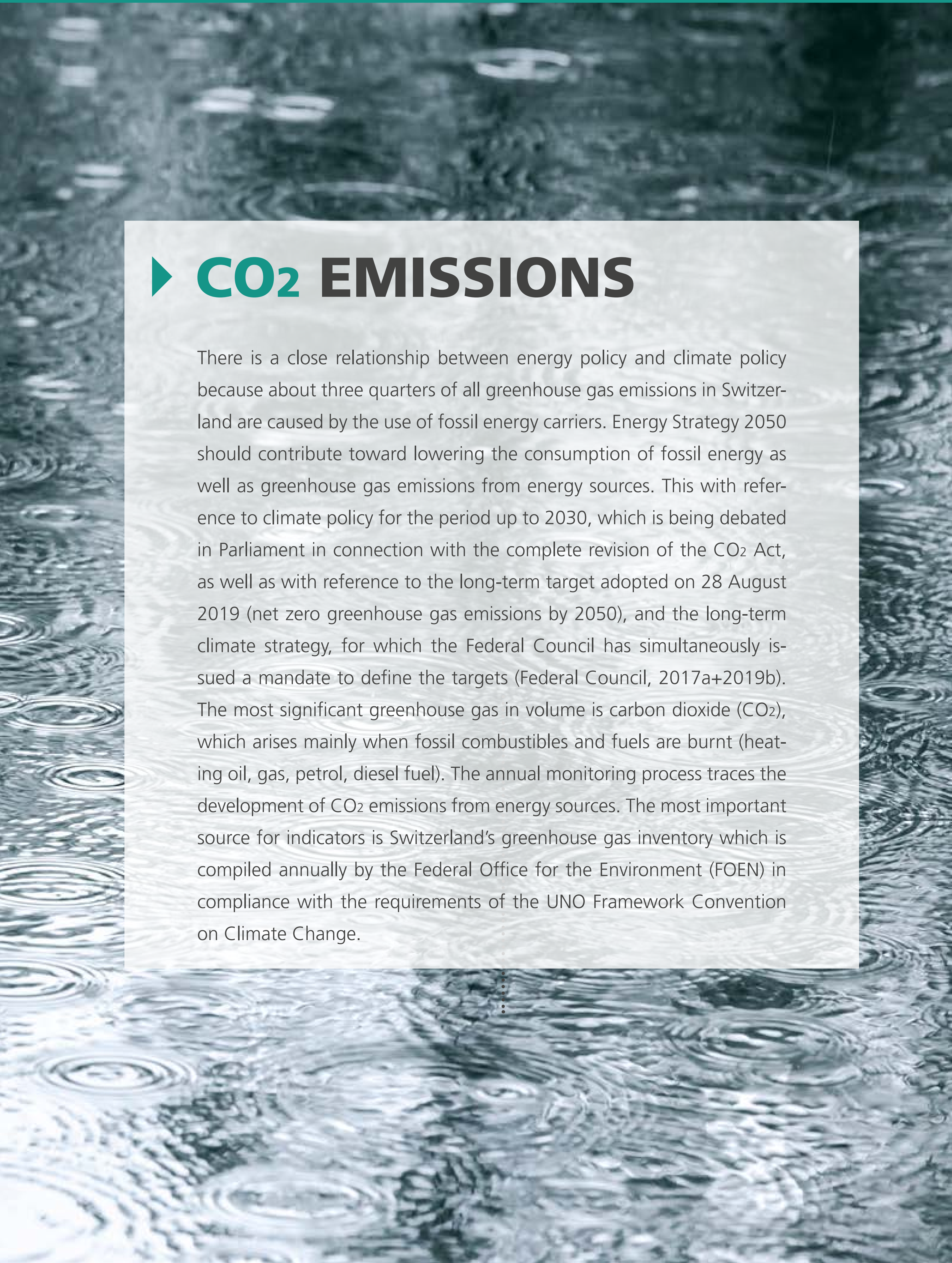


Figure 12: Average nominal retail price for electricity and gas including taxes for the industrial sector in USD (calculated on the basis of market exchange rates)

The **electricity price** depends on many factors, including the technology used in generation, the production and transport costs, capacity of the grids, market structures and levies. The same tendency as seen in Germany, France and the average OECD country can be seen in the development of electricity prices in Switzerland, however, prices in Switzerland in 2018 fell slightly contrary to the general trend in other countries (**cf. figure 12**). Thus, the price level in Switzerland lies close to the OECD average and is lower than that in Germany, or above all that of Italy (Italy had the highest electricity prices throughout the entire time period). The differences in price levels should be interpreted cautiously because companies that consume large amounts electricity can be exempted from paying levies contained in prices and the data base is incomplete. In fact, the prices in Switzerland for those industrial customers who cover their needs on the open market are not compiled. The share of these industrial customers has risen steadily since the market was liberalised. Domestic prices for **gas** are much higher than in Germany and France and about average for OECD countries. In 2010 and 2011, and since 2013, Switzerland has been the most expensive OECD country in this respect. The difference to the other OECD countries is substantial, and in particular in contrast to the US, the country with the lowest prices in 2018. There are a number of possible explanations for the difference in prices. The CO_2 levy on combustibles was increased and this is reflected in the figures. It should also be noted that some companies are able to gain exemption from the fee if they undertake to reduce emissions in return – however this is not shown in the current figures. In fact such companies pay the end-user price but they are able to apply for a refund of the fee. The situation around the CO_2 levy is only a partial explanation for the relatively high prices and is no explanation for the figures before 2008. Further potential explanations could be the higher grid costs (arising because there are only a low number of connections per kilometre) and the current intensity of competition. For example, the gas markets in the countries to which Switzerland is compared are all liberalised. In Switzerland, too, in 2012 gas sales conditions were regulated for major industrial customers on the basis of an association agreement, according to which a few hundred end-users are free to choose their gas supplier. At the end of October 2019, in the course of the consultation procedure about the gas supply act, the Federal Council has proposed that the market should be partially liberalised, a measure which would give significantly more customers (about 40,000 consumption sites) free access to the market. (source: OECD / IEA, 2019a / Federal Council, 2019d).

More detailed indicators on the topic of **EXPENDITURE AND PRICES** (See the detailed version of the Monitoring Report)



CO_2 EMISSIONS

There is a close relationship between energy policy and climate policy because about three quarters of all greenhouse gas emissions in Switzerland are caused by the use of fossil energy carriers. Energy Strategy 2050 should contribute toward lowering the consumption of fossil energy as well as greenhouse gas emissions from energy sources. This with reference to climate policy for the period up to 2030, which is being debated in Parliament in connection with the complete revision of the CO_2 Act, as well as with reference to the long-term target adopted on 28 August 2019 (net zero greenhouse gas emissions by 2050), and the long-term climate strategy, for which the Federal Council has simultaneously issued a mandate to define the targets (Federal Council, 2017a+2019b). The most significant greenhouse gas in volume is carbon dioxide (CO_2), which arises mainly when fossil combustibles and fuels are burnt (heating oil, gas, petrol, diesel fuel). The annual monitoring process traces the development of CO_2 emissions from energy sources. The most important source for indicators is Switzerland’s greenhouse gas inventory which is compiled annually by the Federal Office for the Environment (FOEN) in compliance with the requirements of the UNO Framework Convention on Climate Change.

PER CAPITA CO_2 EMISSIONS FROM ENERGY SOURCES

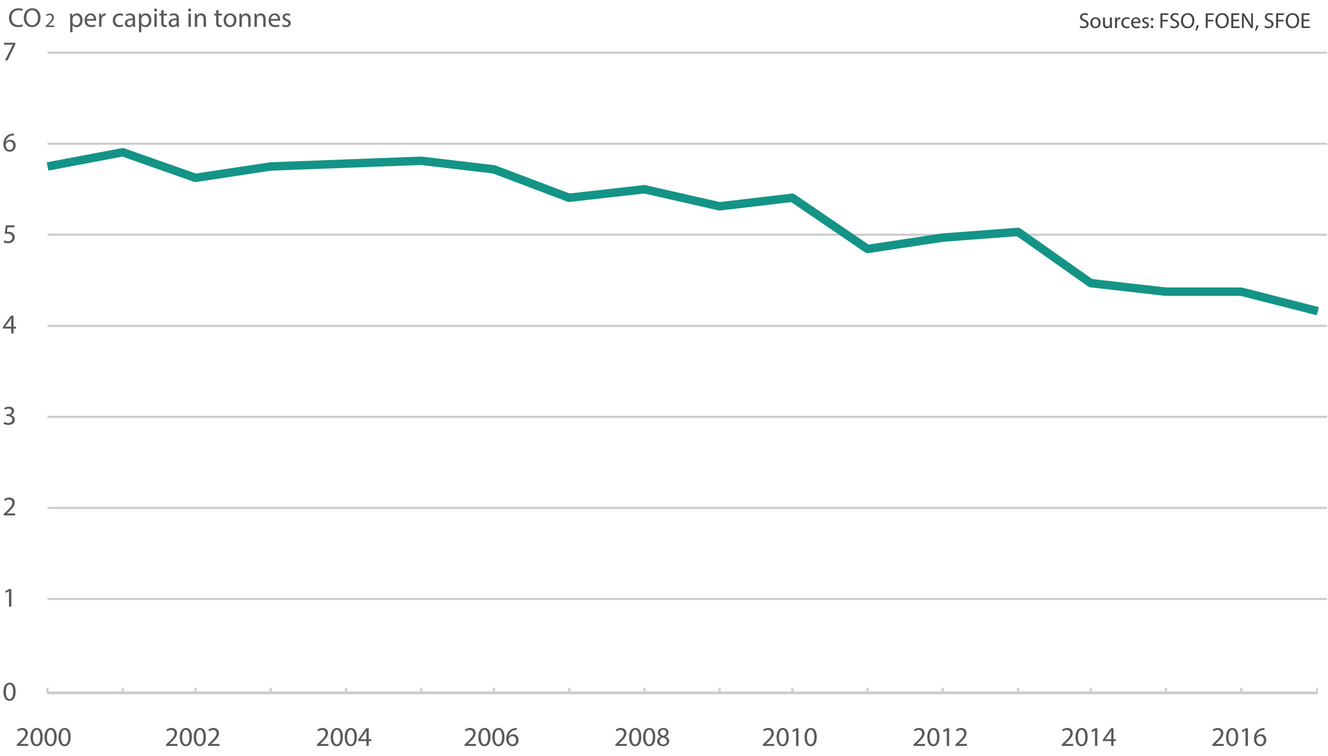


Figure 13: Per capita CO_2 emissions from energy sources (in t CO_2 per capita)[10]

Per capita CO_2 emissions from energy sources have been falling constantly since 2000, as indicated in **figure 13**. While CO_2 emissions from energy sources have fallen slightly since 2000 (**c.f. figure below**), the population of the country has increased in the same time period. There appears to be an increasing separation of the factors population growth and CO_2 emissions. In 2017 domestic per capita emissions were about 4.3 tonnes and thus about 26 percent lower than the value for 2000 (5.8 tonnes). When compared internationally, this is a relatively low value resulting from the fact that Switzerland's electricity production is largely CO_2 free and the service sector contributes a major share of the added value. In order to be able to attain the long-term, strategic, overall objective, toward which the energy strategy is currently oriented[11] (in accordance with the dispatch on the first set of measures for Energy Strategy 2050 – reduction of CO_2 emissions to 1 to 1.5 tonnes by 2050, excluding international air traffic according to the definition of the target) a further continuous per capita decline of about 0.1 tonnes per year is required (sources: FOEN, 2019/FSO, 2019/SFOE, 2019a).

Overall CO_2 emissions from energy sources (**see figure 14**) amounted to almost 36 million tonnes in 2017 and were thus more than 13 percent lower than in the year 2000. The greatest share can be allotted to **transport** (share 2017: 41%; excluding international air traffic), where emissions mainly stem from motorized vehicles. Between 2000 and 2017 CO_2 emissions in the transport sector fell by 0.9 million tonnes. The decline in the trend of visitors from neighbouring countries filling up their vehicles in Switzerland accounts for most of the fall seen since 2015. This trend stopped after the Swiss National Bank decided to abolish the minimum exchange rate for the Swiss franc against the euro. However, international air traffic is playing a greater role. After a decrease seen at the beginning of the millennium, emissions from air traffic have climbed steadily and now constitute more than 5 million tonnes of CO_2[12]. In **Industry** (share 2017: 23%) CO_2 emissions mainly originate from manufacture

CO_2 EMISSIONS FROM ENERGY SOURCES OVERALL AND BY SECTOR

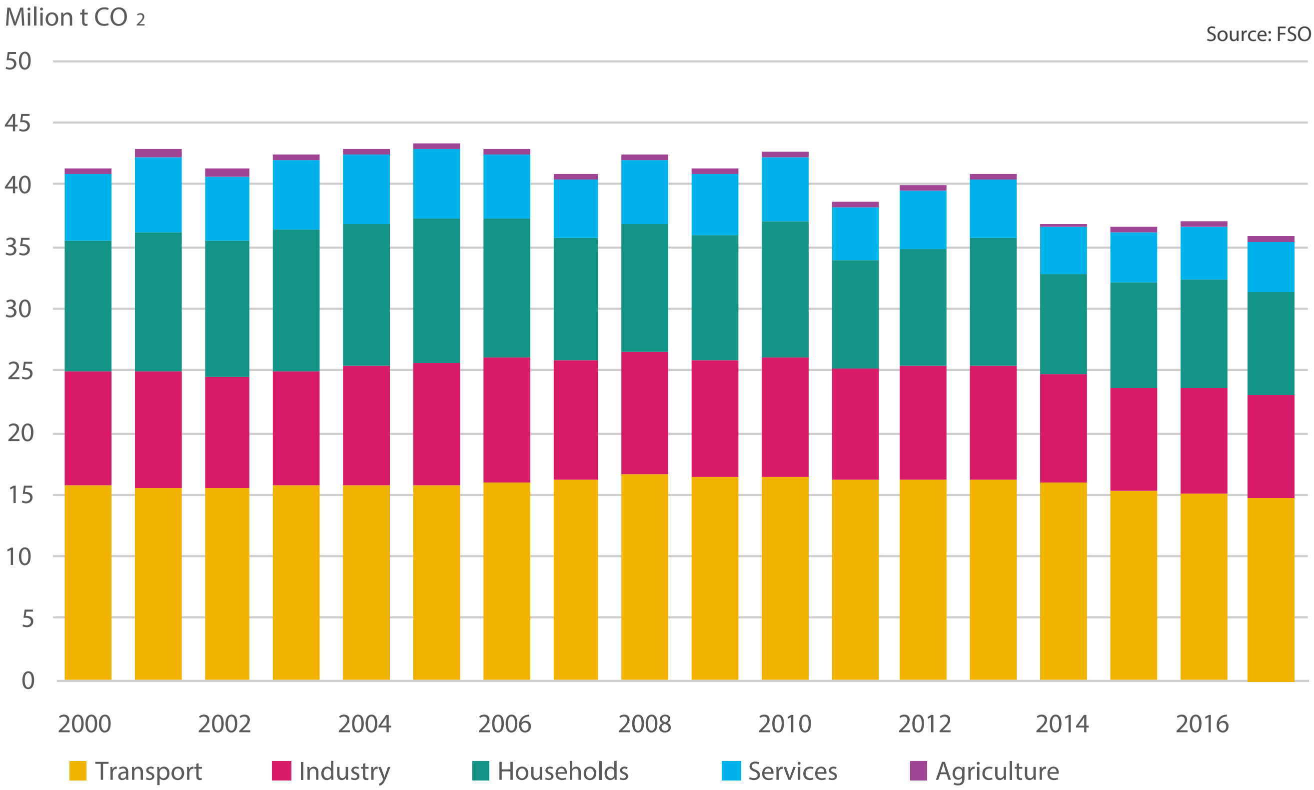


Figure 14: CO_2 emissions from energy sources in total and by sector (in million tonnes CO_2 excluding international air traffic)

of goods and to a lesser extent from building heating. A slight decline has been reported since 2000, showing the effectiveness of the measures implemented as well as increases in energy efficiency and to some extent a decoupling of the factors CO_2 output and industrial production. In addition, an interruption in operations at a refinery, which is still ongoing, led to a perceptible decline in 2015. The variations over the course of time are due to the state of the economy and climatic conditions. In the **Household sector** (share 2017: 23%) emissions originate in the main from heating and hot water heating. Since 2000 emissions have fallen although the dwelling area to be heated has increased. This also shows there has been an increase in efficiency and a tendency to employ technology creating lower emissions of CO_2. However, development of annual emissions is strongly influenced by the climate; dependency on fossil fuel heating systems is also as large as ever. The same applies to the **Services sector** (share 2017: 11%): here, too, CO_2 emissions from energy sources have been declining slightly since 2000. In **Agriculture** CO_2 emissions from energy sources have remained more or less unchanged since 2000 while the overall share in CO_2 emissions is also very low (share 2017: 1%). In this sector greenhouse gas emissions from energy sources are not significant, but those from methane and nitrogen dioxide are. Overall the share of each sector has changed only little since 2000. Emissions from the Transport sector have increased slightly (from 38% to 41%) while Households and Services contributed slightly less (sources: FOEN, 2019+2018/SFOE, 2019a/Ecoplan, 2017/Ecoplan/EPFL/FHNW, 2015).

10 Differentiation according to CO_2 Act (excluding international air traffic, inclduing statistical differences). Not corrected for the influence of climate.

11 This target is currently being checked and will likely be adapted within the work on Climate Strategy 2050, which the Federal Council commissioned on 28 August 2019. Current updates on the energy perspectives constitute a significant basis for this.

12 International air traffic is not included in international balances so no results flow into the evaluation of attainment of climate policy targets. If air traffic were included, its share in overall CO_2 emissions would be about 13 percent. If the sector is assigned to the transport sector, the share would be a full quarter (of emissions).

↗ More detailed indicators on the topic of **CO_2-EMISSIONS** (See the detailed version of the Monitoring Report)

RESEARCH + TECHNOLOGY

It is assumed that the short-term guidelines in the Energy Act and in Energy Strategy 2050 could be attained with the technology available today. However, attaining the long-term goals will require new developments in the technology sector. To stimulate further development, the Federal Council and Parliament have allocated significantly more resources to energy research and new research activities have commenced and existing efforts have been reinforced. Progress in research and technology cannot generally be measured directly with an indicator. For this reason the annual monitoring process focuses on public expenditure for energy research as an indicator for efforts being made in the energy research sector.

PUBLIC EXPENDITURE FOR ENERGY RESEARCH

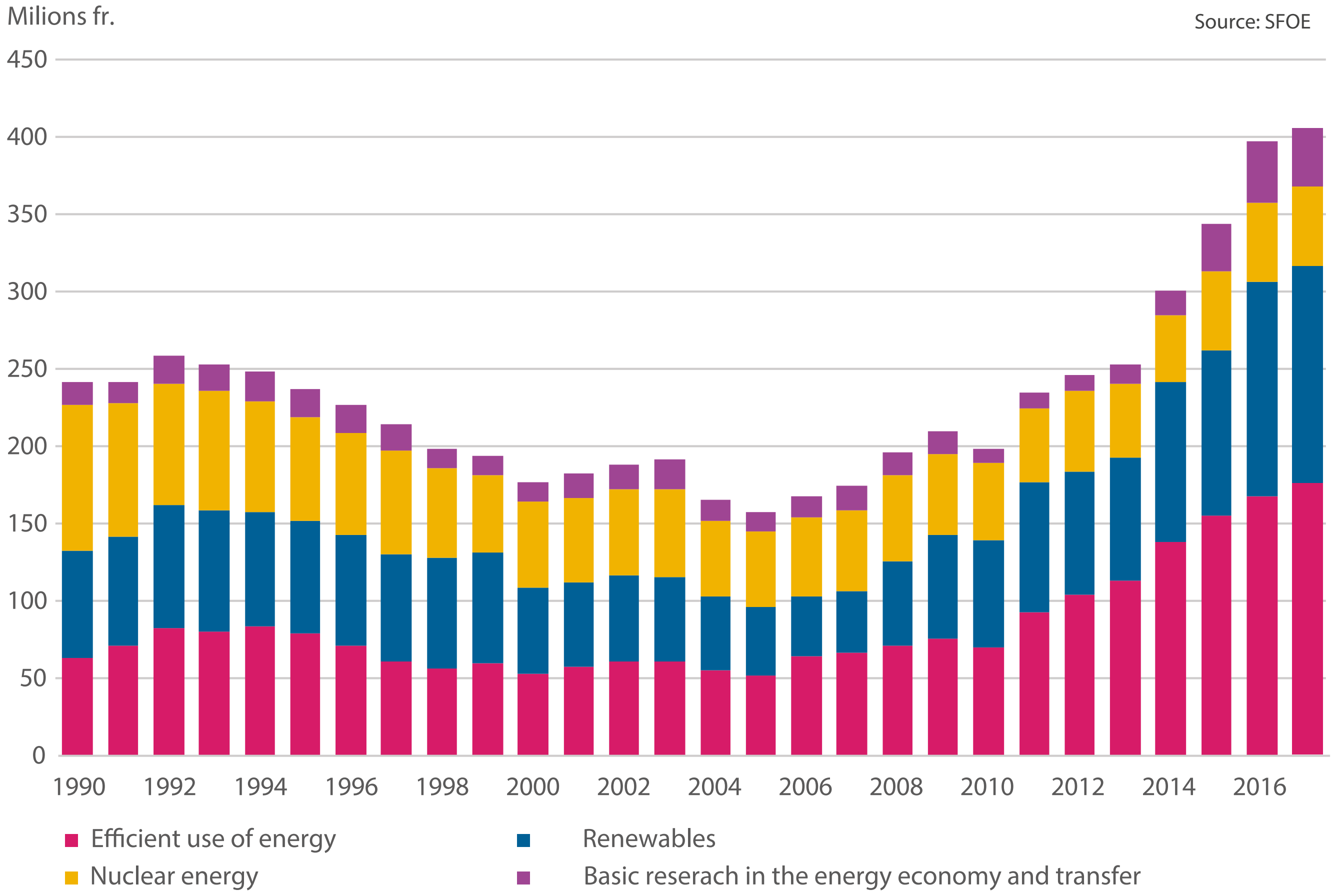


Figure 15: Public expenditure for energy research by field of research (in million francs, actual sum)[13]

Since 2005, public funding for energy research has increased continuously, as indicated in **figure 15**. Above all a significant increase in expenditure has been seen since 2014 within the framework of Energy Strategy 2050 and the Coordinated Energy Research in Switzerland action plan. A major contribution has been made by the establishment of the Swiss Competence Centers for Energy Research (SCCER) by Innosuisse, new National Research Programmes in the energy sector (NRP 70 and 71) by the Swiss National Science Foundation, and targeted expansion of pilot, demonstration and lighthouse activities by the Swiss Federal Office of Energy. In 2017 public expenditure in the sector increased over the previous year overall to almost 410 million francs (actual sum 2016: almost 399 million francs). In accordance with the priorities of Energy Strategy 2050, the greater part flowed into the research fields *Energy efficiency* (share 2017: 43.3%) and *Renewable energies* (share: 2017: 34.7%). Absolute expenditure for *Nuclear energy* research fields (*nuclear fission and atomic fusion*) has remained stable since 2004, however, the share of total expenditure has fallen and amounted to 12.5 percent in 2017. The share in expenditure of the research field Basic *research in the energy economy and transfer* was 9.4 percent in 2017 (source: SFOE, 2019d).

13 Expenditure includes a share in overheads (indirect research costs) of the research institutes.

↗ More detailed indicators on the topic of **RESEARCH + TECHNOLOGY** (See the detailed version of the Monitoring Report)

INTERNATIONAL ENVIRONMENT

The international environment is important to Switzerland because the country is closely integrated into the international energy markets and because Switzerland is strongly dependent on energy imports. On the regulatory level the developments in Europe in particular are crucial to Switzerland. International efforts to combat climate change are also important factors. Changes in the international environment cannot be measured with any indicator. For this reason annual monitoring focusses on a descriptive overview of substantial developments.

DEVELOPMENT OF GLOBAL ENERGY MARKETS

Oil: In its medium-term forecast the International Energy Agency (IEA) states that it expects the global demand for oil to grow annually on average by 1.2 million barrels per day peaking at about 106.4 million barrels per day by 2024. In 2018, the global supply of oil available increased over 2017 by 2.7 million barrels per day to 100.3 million barrels per day. Demand rose by 1.1 million barrels per day to 99.3 million barrels per day. In July 2019, OPEC+ (OPEC and further countries under the chairmanship of Russia) agreed to extend the current cap on production for a further nine months to shore up the price. OPEC+ represents almost half of worldwide oil production. Beginning at the end of September 2018, OPEC opposed an increase in output volume, which led to quotations for Brent crude rising to more than 85 dollars per barrel, making it more expensive than it had been for four years. As early as December 2018, quotations fell to under 60 dollars per barrel and in 2019 were between 60 and 75 dollars per barrel; the attacks on production facilities in Saudi Arabia in mid-September have led to short-term price rises within these limits and to temporary uncertainty on the crude oil markets (sources: OECD/IEA, 2019b+c).

Natural gas: In its medium-term forecast the IEA still assumes that global demand for gas will grow on average by 1.6 percent per annum reaching about 4,300 billion cubic metres by 2024. According to provisional figures from the IEA, in 2018 global gas production increased by 4.0 percent over 2017 to a new record level of 3,937 billion cubic meters. Demand thus increased by 4.9 percent to 3,922 billion cubic meters. In the period between 2015 and the beginning of 2018 gas prices remained relatively constant and lay at about 2 to 3 US dollars per million British Thermal Unit (mmbtu) on the US market (Henry Hub) and at about 4 to 8 US dollars per mmbtu on the European market (TTF spot). In October 2018 the TTF spot price rose to almost 30 euros/MWh, by September 2019 it had fallen again to 11 euros/MWh, the reason for which was the low demand caused by milder weather and an oversupply of LNG (sources: OECD/IEA, 2019d+e/EU, 2019/Argus Gas Connections[14]).

Coal: In its medium-term forecast the IEA makes the assumption that the annual global demand for coal will more or less stagnate until 2023 at a level of 5,530 billion tonnes. Following on 2017 when global coal production increased (+3.1%) an increase of 3.3 percent was also seen in 2018 after a decline occurred for the first time in 2014. Global coal consumption rose in 2018 by 1.2 percent above all because of the increase in consumption in non-OECD countries. Driven by the dynamics of the market in Asia and as a result of China introducing measures to restrict domestic coal production, coal prices rose significantly in the second half of 2016. By July 2018, the CIF ARA spot price was 100 US dollars per tonne, the highest price since 2012, which then fell to about 50 US dollars per tonne by mid-2019 (sources: OECD/IEA, 2018+2019f/Argus Gas Connections).

CO_2 in the European Union Emission Trading Scheme: After the price for CO_2 emission rights in the European Emission Trading Scheme had remained at about 5 euros per tonne of CO_2 equivalent (tCO_2e) since 2013, it rose between mid-2017 and September 2018 and in the meantime has reached in excess of 25 euros/tCO_2e. In the second quarter of 2019 the price of CO_2 was relatively stable moving within the scope of 24 and 28 euros/tCO_2e after having been very volatile at the beginning of 2019 (sources: EU, 2019/EEX[15]).

Electricity: Electricity production increased globally between 1974 and 2017 from 6,298 TWh to 25,721 TWh, corresponding to an average annual growth rate of 3.3 percent according to the IEA. In 2017 production was 2.5 percent higher than in 2016. The European Power Benchmark (index for the average wholesale power price on the European market) reached 43.3 euros/MWh in the second quarter of 2019, and was therefore one percent lower than in the same quarter in 2018. In 2018, the lowest price of about 40 euros/MWh was seen in April, the highest price of about 65 euros/MWh in the months of September and November. The Power Benchmark recored the lowest value since 2007 of 30 euros/MWh in February 2016. The baseload price for Switzerland (Swissix) followed suit (sources: OECD/IEA, 2019g / EU, 2019).

14 www.argusmedia.com
15 EEX

DEVELOPMENTS IN THE EU: CLEAN ENERGY PACKAGE

To implement the Energy Union, in 2018 and 2019 the EU implemented a comprehensive package of new rules for the electricity market, renewable forms of energy, security of supply, energy efficiency measures and governance. The core elements of the package are as follows:

Redesign of the electricity market: The revised version of the *Directive for the internal market in electricity*, which arose from the third internal market in energy package adopted in 2009, was drawn up with the intention of creating a market-based, consumer centred, flexible electricity market. The revised *Regulation on the internal market in electricity*, which also arose from the third internal market in energy package, establishes new regulations for the European domestic market in electricity which is adapted to the increasingly decentralised, fluctuating generation of electricity. How the EU internal market in electricity functions in the future is significant to Switzerland.

Agency for the Cooperation of Energy Regulators (ACER): The new version of the ACER Regulation adapts the role of the agency to comply with the new legal framework for the internal electricity market and for the security of the electricity supply. The overall aim is to strengthen the role played by ACER. In view of the fact that Switzerland is surrounded by the domestic EU electricity market, ACER's work has an effect on the local electricity market and is of particular relevance to ElCom. Switzerland's cooperation with ACER will be limited if no agreement is reached on the electricity market.

Energy efficiency: As a result of the Paris Convention, targets the EU adapted the targets for the *energy efficiency directive* to conform to the energy policy framework for 2030. A non-compulsory efficiency target for the Union of 32.5 percent now applies. The purpose of the updated *building efficiency directive* is to make buildings more 'intelligent' and provide support for building refurbishment. Switzerland is not affected by the directives.

Renewable forms of energy: The revised *Directive on the promotion of the use of energy* from renewable sources should lead to further increasing the share of renewable energies in the overall energy mix by 2030. A binding target of 32 percent for renewables now applies within the EU. Among other things, the directive contains regulations for promotion, self-generation and own use, for the heating market, for guarantee of origin (GO), as well as sustainability criteria for bio-energy. If no agreement on electricity is reached, recognition of Swss guarantees of origin will cease to apply because the Clean Energy Package only foresees accepting GO from third countries with an agreement. Up to now member states could decide in their own right which third country guarantees of origin they would accept.

Security of the electricity supply: The purpose of the new Regulation on *risk-preparedness in the electricity* sector is to prepare member states to manage energy crisis situations which could be caused by extreme weather circumstances, cyber-attacks, or a fuel shortage. The wording and implementation of the new regulation are relevant to Switzerland because of the close ties to the EU in the energy sector.

Governance of the Energy Union: The aim of the new *Governance Regulation* is to create a mechanism to plan, report and monitor achievement of targets set by the Energy Union. At the end of 2018, the EU states submitted initial drafts of these plans in which they presented their national targets, policies and measures for the five dimensions of the Energy Union. The Commission presented its evaluation of the drafts in June 2019 in which they called for greater efforts to ensure the EU could attain its targets by 2030. By the end of 2019, the states are required to deliver the final plans and thereafter provide regular reports about their energy and climate policies.

The new regulation and directive on the internal market in electricity, the regulation about risk preparedness in the electricity sector and the ACER regulation went into force in mid-2019. The regulation on the governance system for the Energy Union, the amended energy efficiency measures directive, the amended directive on renewable forms of energy and the directive for the energy performance of buildings went into force in 2018. The regulations apply in EU member states immediately upon enactment (commencement of validity of the regulation on the internal market in electricity: 1 January 2020). The directives have to be implemented in national law within 18 months.

(Sources: COM [2016] 860 final / Council of the European Union, 2018 / COM, 2019a+b)

INTERNATIONAL CLIMATE POLICY

To further implement the **Paris Convention**, the community of states drafted a number of decisions and elaborated directives at the climate conference at Katowice in Poland in mid-December 2018. The policies should guarantee the transparency necessary for effective implementation of the Convention, among other things. After years of negotiation on the part of the international community, the Paris Convention went into force on 4 November 2016. It continued on from the second commitment period of the Kyoto Protocol and obliges all states to adopt measures to reduce greenhouse gas emissions holding the increase in the global average temperature to well below 2 degrees Celsius above pre-industrial levels while at the same time striving to limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels. The further aims of the Convention entail improving adaptability to the non-avoidable consequences of climate change and making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development. In the meantime all 197 parties to the United Nations Framework Convention on Climate Change (UNFCCC) have adopted the Convention and 186 have already ratified it. On 1 June 2017, the President of the United Sates Donald Trump announced the USA wanted to withdraw from the Paris Convention. Thus the USA would become the only contracting party that will not participate in the Convention. However, formal exit from the convention is only possible in November 2020 because of the effective notice period. Until then the USA is legally party to the Convention.

Switzerland ratified the Convention on 6 October 2017 after the Federal Assembly had given its approval on 16 June 2017. By approving the Convention the Federal Assembly also voted in favour of reducing greenhouse gases overall by 50 percent by 2030 in comparison to levels in 1990. The proviso was added that allocation of the reduction between the domestic share and the reduction achieved abroad would be determined in the process of national implementation. Since the ratification of the Convention Switzerland has been legally obliged to introduce measures to contain emissions and adapt to climate change. In addition a Biennial Report has to be submitted as before to the Secretariat of the UNO Convention on Climate Change about the development of greenhouse gas emissions, measures planned to reduce emissions and adapt to climate change, and the contributions made to financing international climate policy. The Paris Convention now has to be implemented in national law. On 1 December 2017 the Federal Council submitted the bill on the total amendment of the CO_2 Act which is currently under consideration by Parliament.

In 2018, the Intergovernmental Panel on Climate Change highlighted in a special report the consequences of global warming of 1.5 degrees Celsius and compared these consequences with those of global warming by 2 degrees Celsius. The report made clear serious changes in the ecological system would have to be anticipated with global warming of 1.5 degrees and that the changes would be even more significant with additional warming of 2 degrees. To restrict global warming to 1.5 degrees, a CO_2 balance of net zero would have to be reached by the middle of the century. As a consequence of this information, the Federal Council commissioned the FOEN to check the long-term climate targets once again and to elaborate what possible action could be taken. The on 28 August 2019 the Federal Council decided that by 2050 Switzerland should no longer emit any further greenhouse gases because natural and technical storage facilities (sinks) could take up the gases. This will mean zero emissions by 2050. This climate target will ensure Switzerland makes its contribution to limiting global warming to a maximum of 1.5 degrees Celsius.

(Sources: Federal Council, 2017+2019a / IPPC, 2018).

INTERNATIONAL COOPERATION IN THE ENERGY SECTOR

Switzerland is negotiating **a bilateral electricity agreement** with the EU. In the main the negotiations centre upon mutual access to the electricity market. The content and scope of the agreement have been largely defined. Some questions in different sectors of the agreement are still the subject of negotiations. These talks have been suspended since mid-2018, because the EU has coupled the continuation of the negotiations with the progress made on the institutional agreement between Switzerland and the EU. The legal framework in the EU in the energy sector has changed comprehensively because of the Clean Energy Package (CEP). It is likely that a change in the negotiation mandate will be required because negotiations will have to be based on the CEP and not as up to now on the third package of measures for the internal electricity market.

With respect to **regional cooperation**, Switzerland has participated as a permanent and active observer of the Pentalateral Energy Forum since February 2011. The energy ministries of the following countries all take part voluntarily in the Forum: Germany, France, Belgium, The Netherlands, Luxembourg, Austria and Switzerland. Up to now the work of the forum has revolved around three topics: the electricity market, security of the electricity supply, and flexibility in the electricity market. Now the Forum is also discussing the topic of hydrogen. At the beginning of March 2019 the energy ministers of the Pentalateral states signed a nonbinding policy statement in which they undertook to draft a mutual chapter about cooperation in the forum and about their national energy and climate plans (NECP)[16] and concerning topics in the energy field that they would like to see tackled in regional cooperation. Switzerland will continue to work within the Pentalateral Forum.

The numerous interdependencies with neighbouring countries in the energy sector call for deepening of **bilateral relations**. In the discussions held by Federal Councillor Simonetta Sommaruga in Denmark and Sweden at the end of March, it was highlighted how closely energy and climate policy is linked to economic policy. In a working visit to Germany in April the key topics were future energy policy, the impacts of Germany phasing out the use of coal, and the importance of hydropower in the reorganisation of the energy system. During the visit in mid-September to Bern of the Minister for Energy and Spatial Development of Luxembourg both countries discussed the challenges presented by the energy transition and Switzerland's activities in the electromobility, energy in buildings and energy research fields. In October, Federal Councillor Sommaruga and a delegation from the Swiss energy and cleantech branches visited India and met the Indian minister for electricity and renewable energy.

In the field of **multilateral cooperation** Switzerland is active within the multilateral energy institutions including the International Energy Agency (IEA). Within the Energy Charter Treaty, Switzerland has suggested that negotiations about modernising the treaty should be held after 2020 with the emphasis on adapting it to conform with the current requirements to reduce CO_2 and to the new practices in international investment treaties. In January 2019, Switzerland organised a workshop about hydropower on the periphery of the annual meeting of the International Renewable Energy Agency. Switzerland will have a seat on the IRENA board from 2019 to 2020. Switzerland also cooperates with the UNO International Atomic Energy Agency. (Sources: Federal Council, 2019a+b/DETEC, 2018+2019)

16 The governance regulation for the energy union obliges EU member states to compile and deliver to the Commission a national energy and climate plan for the period from 2021-2030 by the end of 2019 (see above). Switzerland will not compile such a plan but has cooperated in drafting the mutual chapter of the Pentalateral Energy Forum.

↗ More detailed information on the topic **INTERNATIONAL ENVIRONMENT** (See the detailed version of the Monitoring Report)

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LIST OF FIGURES

IMPRINT

NOVEMBER 2019

Publisher:
Swiss Federal Office of Energy SFOE

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