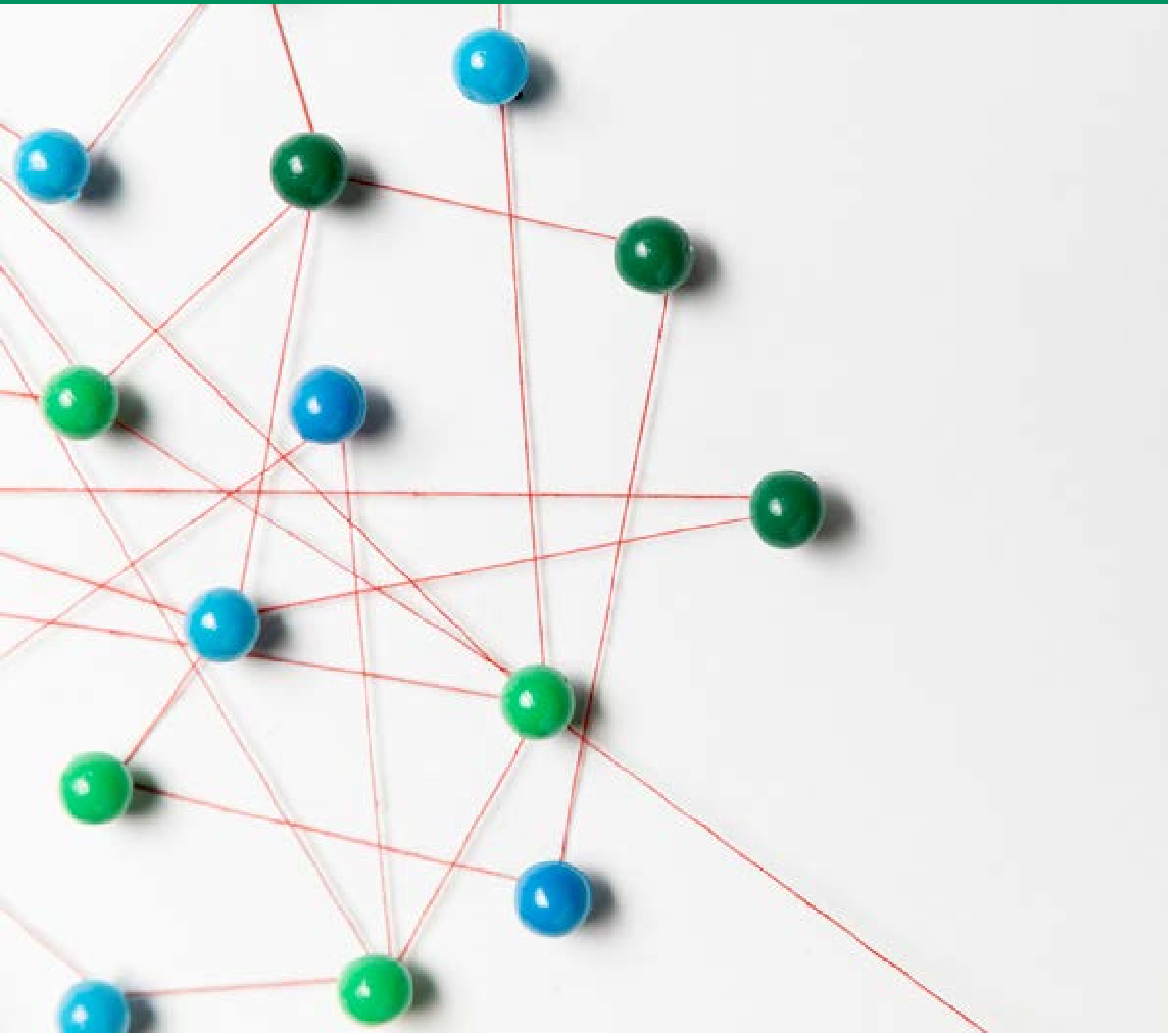

ENERGY STRATEGY 2050
MONITORING REPORT 2023
ABRIDGED VERSION[1]

1 Based mainly on data up to 2022. No annual monitoring report was published in 2022. Instead, the Federal Council adopted the first five-year monitoring report at the end of 2022 (Federal Council, 2022c).

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Swiss Federal Office of Energy SFOE

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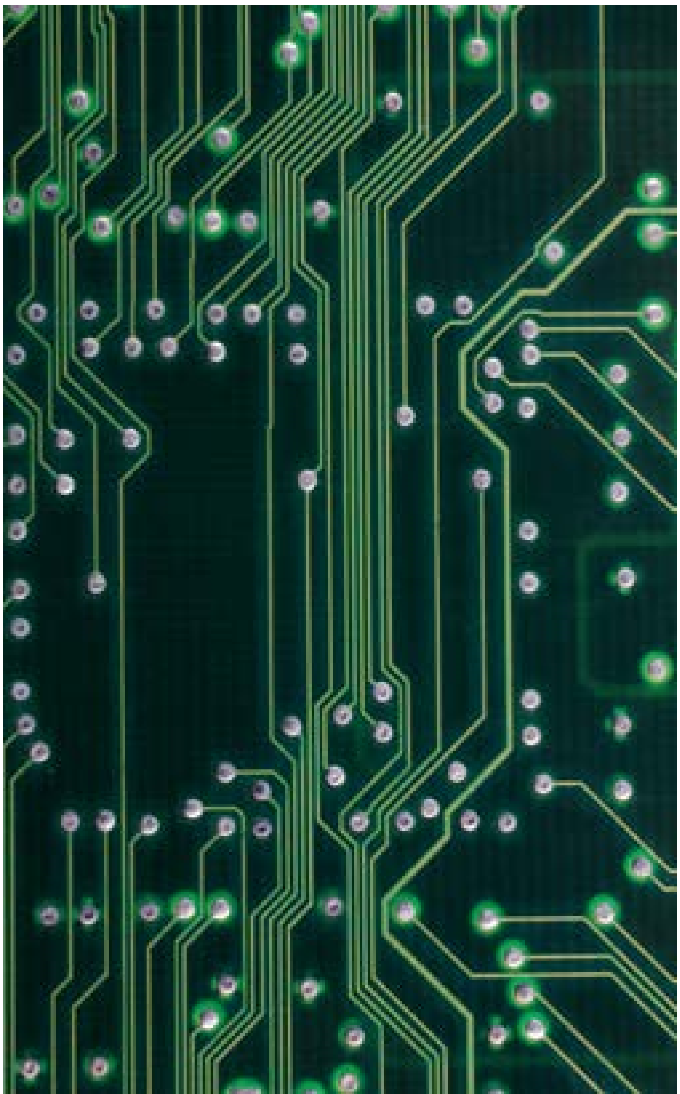

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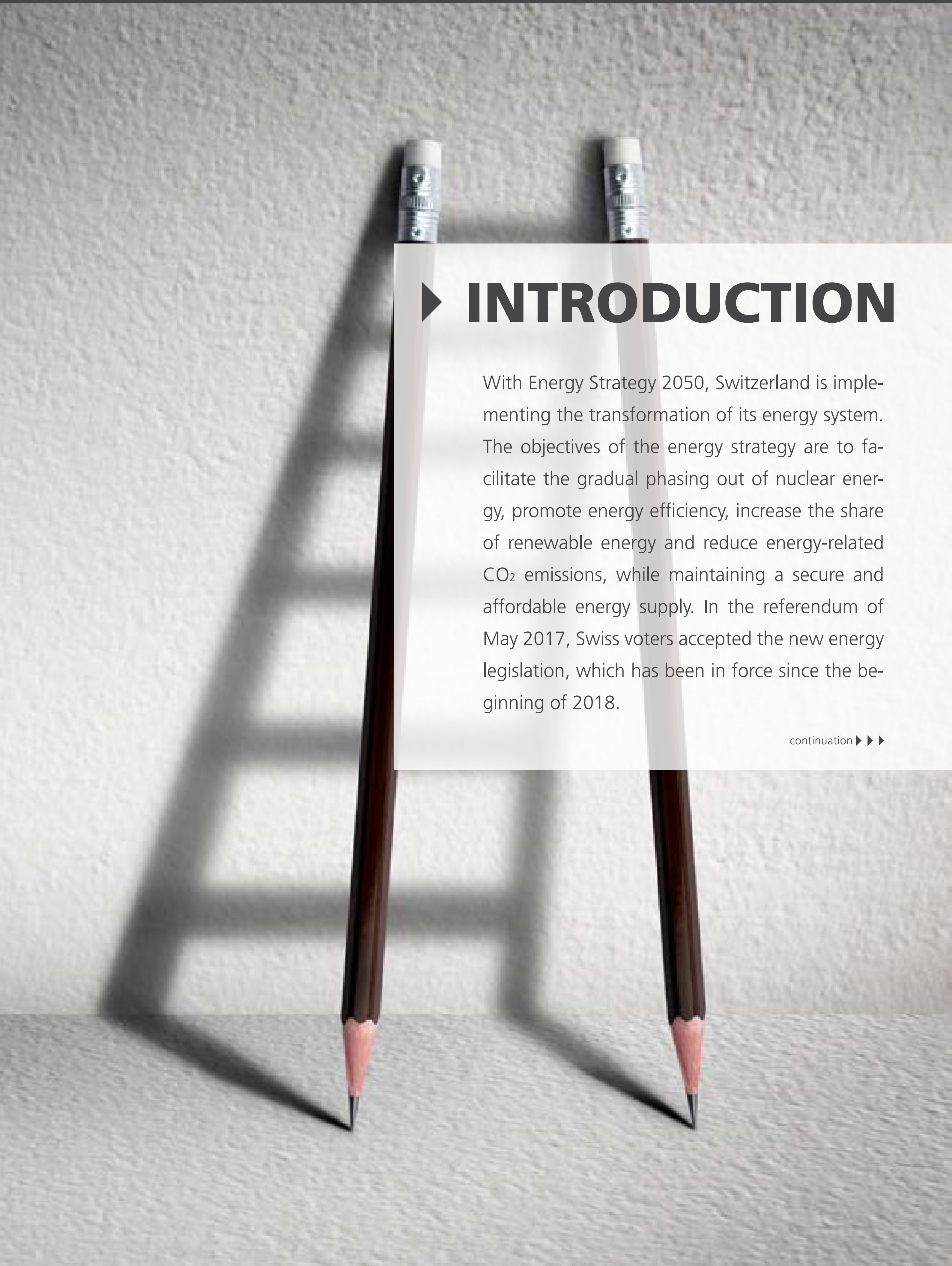


INTRODUCTION

With Energy Strategy 2050, Switzerland is implementing the transformation of its energy system. The objectives of the energy strategy are to facilitate the gradual phasing out of nuclear energy, promote energy efficiency, increase the share of renewable energy and reduce energy-related CO_2 emissions, while maintaining a secure and affordable energy supply. In the referendum of May 2017, Swiss voters accepted the new energy legislation, which has been in force since the beginning of 2018.

continuation ▸ ▸ ▸

In light of the new climate target for 2050 (*see below*) fossil fuels will largely need to be replaced by renewable electricity, particularly in the areas of transport and heating. The Federal Act on a Secure Electricity Supply from Renewable Energy Sources will feed into the development of the Energy Strategy 2050. The Swiss parliament adopted the Act in its 2023 autumn session. It is due to enter into force on 1 January 2025 (subject to a referendum vote). The Act sets out various measures to swiftly and systematically scale up domestic renewable power generation, to better integrate it into the power system, and to enhance longterm security of supply. To further accelerate the expansion of renewable energies, the Federal Council approved an amendment to the Energy Act – known as the acceleration bill – in June 2023 and it has been submitted to Parliament (Federal Council 2023e). The main aims of the bill are to streamline the licensing and appeal process for large installations and to simplify the planning process for grid upgrades. The acceleration bill supplements the bills on fasttracking wind and solar energy projects that have already been approved by Parliament.

The energy policy objectives are closely linked to those of the climate policy, since around three quarters of Switzerland's greenhouse gas emissions are attributable to the use of fossil fuels. Switzerland's aim is to no longer produce any greenhouse gases by 2050 that cannot be absorbed naturally or by technical means. The Federal Council declared its net zero target in 2019 (Federal Council, 2019a). The updated Energy Perspectives 2050+ of the Swiss Federal Office of Energy (SFOE) shows that Switzerland can restructure its energy supply by 2050 in harmony with this target, and simultaneously ensure its supply security (Prognos/TEP/Infras/Ecoplan, 2020). The SFOE's Energy Perspectives 2050+ forms an important basis for 'Switzerland's Long-Term Climate Strategy', which the Federal Council adopted in January 2021 in order to consolidate its net zero target. It presents the guidelines for climate policy up to 2050 and sets out strategic goals for the various sectors (Federal Council 2021a). On 18 June 2023 the Swiss electorate voted in favour of the Federal Act on Climate Protection Goals, Innovation and Strengthening Energy Security (CIA). It had been brought as a parliamentary initiative (Pa.Iv 21.501) by the ESPEC-N as an indirect counter-proposal to the Glacier Initiative. This new legislation makes the previously indicative net zero target a legally-binding objective. It also sets out interim goals and sectoral guidelines. The Act also comprises various support measures to achieve climate neutrality by 2050.

Switzerland has pledged to cut its greenhouse gas emissions by 50% by 2030 versus the 1990 baseline. The national implementation of this target and the corresponding measures were stipulated in the revised CO_2 Act, which the Swiss electorate rejected in the referendum that was held in June 2021. However, the reduction target for 2030 is still valid. In September 2022, the Federal Council therefore adopted the dispatch on a new revision of the CO_2 Act for the period from 2025 to 2030 (Federal Council 2022d). The bill dispenses with some of the instruments that caused the last revision to be rejected by the electorate. It is currently being discussed in Parliament. In order to extend the uncontested measures of the CO_2 Act that expired at the end of 2021, and to continue the national reduction target until the end of 2024, Parliament decided on a partial revision of the CO_2 Act on the basis of a parliamentary initiative (Pa. Iv. 21.477) by the ESPEC-N. The partial revision entered into force retroactively on 1 January 2022.

Due to the lengthy timeframe, a monitoring process is required. This makes it possible to observe the relevant developments and progress, measure the degree to which the various targets are attained, examine the benefits and economic costs of the various measures, and take timely, fact-based action in the event of undesirable developments. Energy legislation provides the legal basis for monitoring (Articles 55ff of the Energy Act and Articles 69ff of the Energy Ordinance).

This monitoring report for 2023 (abridged version, based mainly on data up to 2022) deals with selected indicators and contains descriptive sections on the following seven topics:

- **TOPIC** **ENERGY CONSUMPTION AND PRODUCTION**
- **TOPIC** **NETWORK DEVELOPMENT**
- **TOPIC** **SUPPLY SECURITY**
- **TOPIC** **EXPENDITURE AND PRICES**
- **TOPIC** **CO_2-EMISSIONS**
- **TOPIC** **RESEARCH AND TECHNOLOGY**
- **TOPIC** **INTERNATIONAL ENVIRONMENT**

↗ Additional indicators are dealt with in **the full version of the monitoring report**: **www.energymonitoring.ch**

↗ **Key figures on the current energy supply situation** are available on the SFOE's Energy Dashboard at **www.energydashboard.ch**

ENERGY CONSUMPTION AND PRODUCTION

Reducing energy and electricity consumption by enhancing efficiency measures is one of the main objectives of Energy Strategy 2050 and is 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 targets in the Energy Act for per capita energy and electricity consumption, as well as the goals for the expansion of electricity production from renewable energy and for hydropower. Through the Federal Act on a Secure Electricity Supply from Renewable Energy Sources, Parliament has laid down new binding targets for 2035 and 2050. The Act is due to enter into force on 1 January 2025 (subject to a referendum vote). The following charts and comments therefore also refer to these new binding targets.

END ENERGY CONSUMPTION PER PERSON AND YEAR

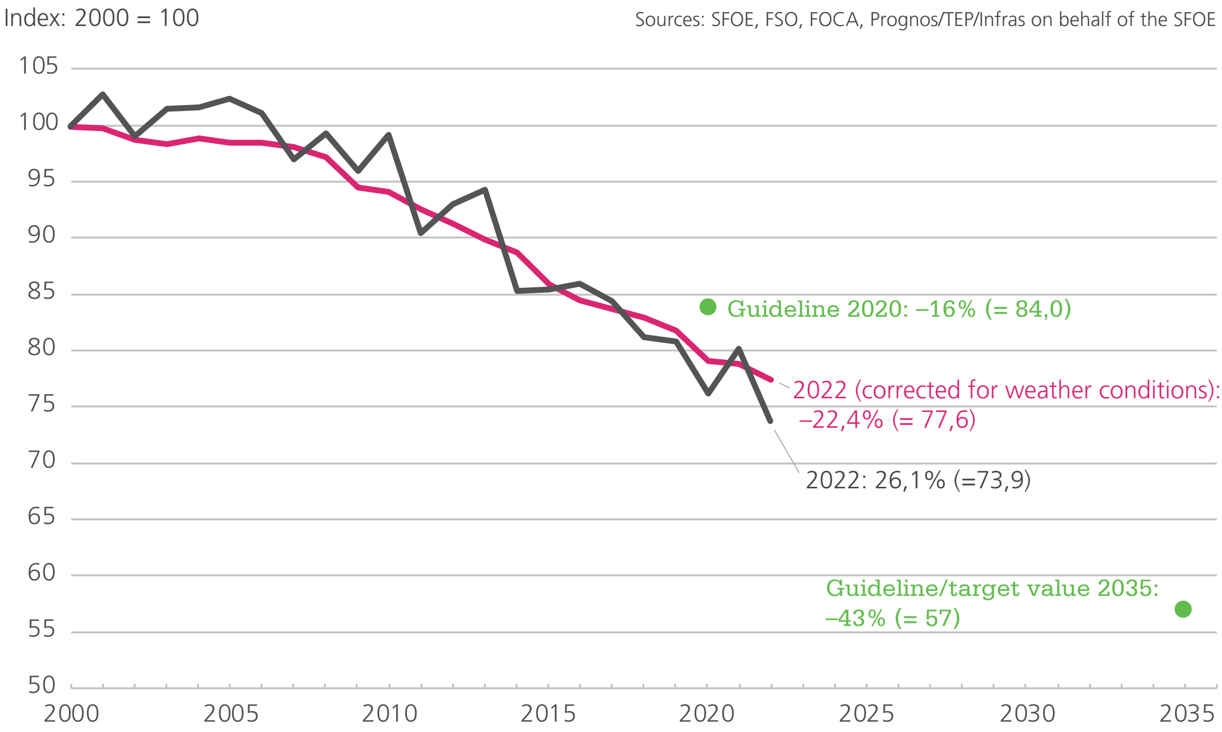


Figure 1: Development of per capita end energy consumption[2] since 2000 (indexed)

Per capita end energy consumption has fallen since 2000, as shown in **Figure 1**. The decline is a consequence of the lower absolute final energy consumption in 2022 (9.8%) versus 2000, while at the same time the population increased by 22.2%. The target reduction in per capita energy consumption compared with the 2000 baseline amounts to 16% by 2020 and 43% (guide value) by 2035 under the current Energy Act. The Federal Act on a Secure Electricity Supply from Renewable Energy Sources makes this 43% target by 2035 a binding objective. In 2020, per capita energy consumption was 80.6 gigajoules (22.4 MWh), and thus 26.1% lower than in 2000. Adjusted for weather conditions, the decrease was 22.4%. Per capita final energy consumption (adjusted to take account of the weather) will in future have to fall by 2.2% per annum to ensure that the target for 2035 can be achieved. In the past 10 years, the average annual decline after adjustment for the weather was around 1.6%. The absolute final energy consumption in 2022 was 3.9% lower than in the previous year (or 7.4% excluding international air traffic). This decline is primarily due to the milder weather, which caused a year-on-year drop in demand for heating. The Confederation's energy savings campaign and the significant increase in energy prices likely contributed to reduced energy consumption in 2022 as well. Over the entire period under review (from 2000 to 2022), volume effects led to increased consumption; all 'pure' growth effects were counted, such as the overall economic output (excluding structural effects), population, energy reference areas and the motor vehicle inventory. Effects that tended to increase consumption were offset by political measures and technological progress. Substitution of heating oil with gas and the increasing use of district heat, ambient heat and wood tended to reduce consumption between 2000 and 2022. In terms of fuel, the trend to substitute petrol with diesel was noted until 2016; since then the effect of this change has become less significant as a consequence of the exhaust emissions scandal (sources: SFOE, 2023a/FSO, 2023a/FOCA, 2023/Federal Gazette, 2023/Prognos/TEP/Infras 2023a+b).

2 Excluding international air traffic

ELECTRICITY CONSUMPTION PER PERSON AND YEAR

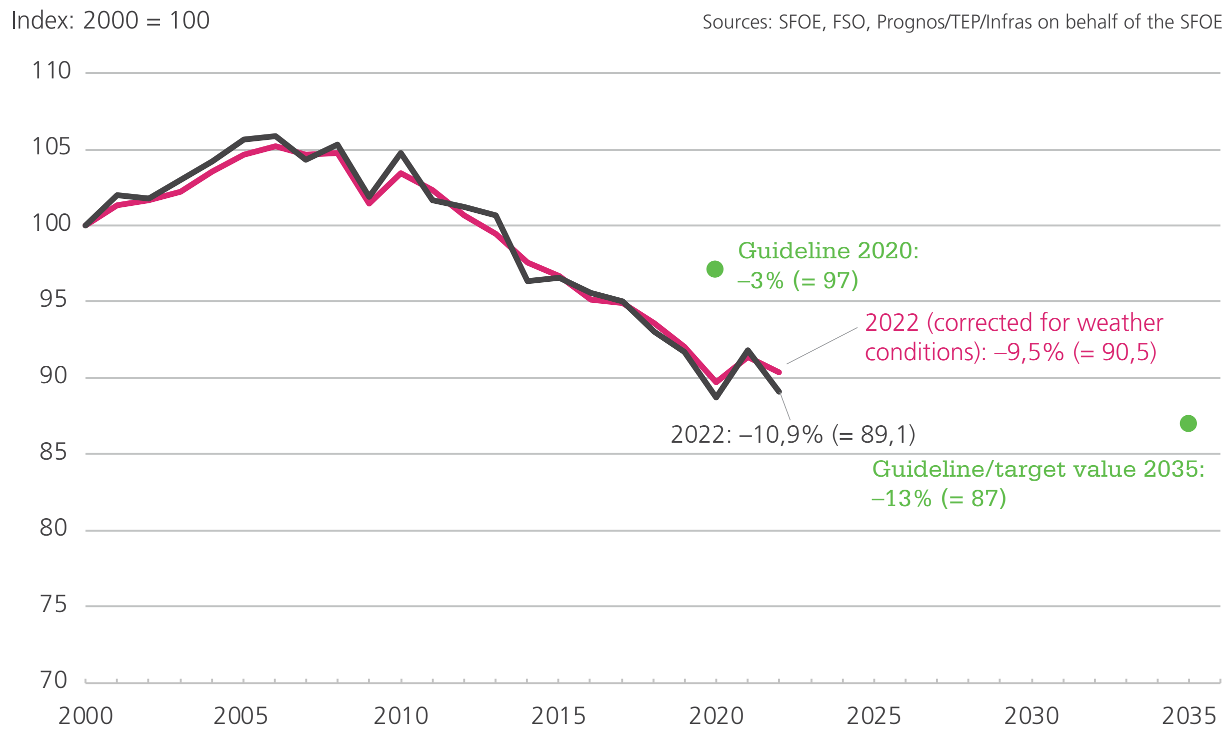


Figure 2: Development of per capital electricity consumption since 2000 (indexed)

Per capita electricity consumption increased between 2000 and 2006 because absolute consumption rose by 10.4%, while the population only increased by 4.2%. Since 2006, the trend has been downward, as we can see from **Figure 2**. Electricity consumption decreased by 1.3% between 2006 and 2022, while the population increased during the same period by 17.3%. The sharp decline in per capita consumption in 2009 is a result of a clear economic slowdown, and that in 2020 is due to the impact of the COVID-19 pandemic. Under the applicable Energy Act, the targeted reduction in per capita electricity consumption compared with the 2000 baseline is currently 3% by 2020 and 13% by 2035. The Federal Act on a Secure Electricity Supply from Renewable Energy Sources will make this 13% target by 2035 legally binding. In 2022, per capita electricity consumption was 23.4 gigajoules (6,498 kWh) and thus 10.9% lower than in 2000. When adjusted to take account of the weather, the decline was 9.5% (*cf. red curve*). In the past 10 years, the average annual decline after adjustment for the weather was around 1.05%. In order to achieve the declared climate objective of net zero greenhouse emissions by 2050, according to Energy Perspectives 2050+ a significant increase in electricity demand has to be anticipated in the medium term, and this will make it more difficult to achieve the target (electric mobility, standard heat pumps, new consumers such as electrolysers for hydrogen production, large-scale heat pumps, and in the long term, negative emission technologies and systems for CO_2 capture and storage). The target for 2035 (**–**13%) will therefore not be met without further efforts. In 2022, the absolute

ELECTRICITY CONSUMPTION PER PERSON AND YEAR

electricity consumption decreased by 1.9% versus 2021. The main reason behind this decline was the milder weather compared with the previous year. Efficiency increases and the federal government's energy saving campaigns have also contributed to the reduction. The long-term increase in electricity consumption over the entire period under review (from 2000 to 2022) was mainly due to volume effects and, to a lesser degree, to substitution effects (e.g. replacement of fossil fuel heating systems with heating pumps and conventionally-fuelled cars with electric vehicles) and structural effects (e.g. different growth rates in the individual sectors). Energy policy instruments and measures (e.g. political targets and the voluntary measures from the SwissEnergy programme) and technological developments (structural measures such as insulation and use of more efficient heating systems, electrical appliances, lighting, machines, etc.) had the opposite effect and increasingly tended to reduce electricity consumption (sources: SFOE, 2023a / FSO, 2023a / Federal Gazette, 2023 / Prognos / TEP / Infras 2023a+b / Prognos / TEP / Infras / Ecoplan, 2020).

ELECTRICITY PRODUCTION FROM RENEWABLE ENERGY (EXCLUDING HYDROPOWER)

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

The guidelines stipulated in absolute figures in the applicable legislation (Energy Act, Article 2, paragraph 1) refer to domestic production, which corresponds to the sphere of influence of the legal instruments. Here it should be noted that these targets are no longer compatible with the climate objective of net-zero greenhouse gas emissions by 2050. Through the Federal Act on a Secure Electricity Supply from Renewable Energy Sources, Parliament has laid down new binding targets for 2035 and 2050. The Act is due to enter into force on 1 January 2025 (subject to a referendum vote).

Electricity production from renewable sources has increased since 2000, as indicated in **Figure 3**. Production gained momentum from 2010 onwards. In 2022 it reached 6,019 gigawatt-hours (GWh), which corresponds to 10.4% of the overall net electricity production (excluding consumption by storage pumps). In reference year 2010, electricity production from renewable energy was 1,403 GWh. In 2022, the net increase versus 2021 was 1,039 GWh; since 2011 it has averaged 385 GWh per annum. In accordance with the current Energy Act, the target for 2035 is 11,400 GWh. In order to achieve this target, an average net increase of 414 GWh per annum will be required. A significantly higher increase of 2,229 GWh per annum is required to achieve the target of 35,000 GWh in accordance with the Federal Act on a Secure Electricity Supply from Renewable Energy Sources, which has been adopted by Parliament.

The breakdown by technology shows that the expansion is not happening at the same pace for all types of renewable power generation. Since 2010, photovoltaics (PV) has seen the sharpest increase in absolute terms, now accounting for around 64.1% of new renewable power generation. Growth in the other technologies is much lower: power generation from incineration plants and renewable wastes (contributing the most to renewable power generation after photovoltaics, at 18.1%), from furnaces burning wood and wood fuels (share in 2022: 8.5%), from biogas (share in 2022: 6.8%), wind energy plants (share in 2022: 2.5%). There are not yet any geothermal power plants in Switzerland (source: SFOE, 2023a/Federal Gazette, 2023).

ELECTRICITY PRODUCTION FROM HYDROPOWER PLANTS

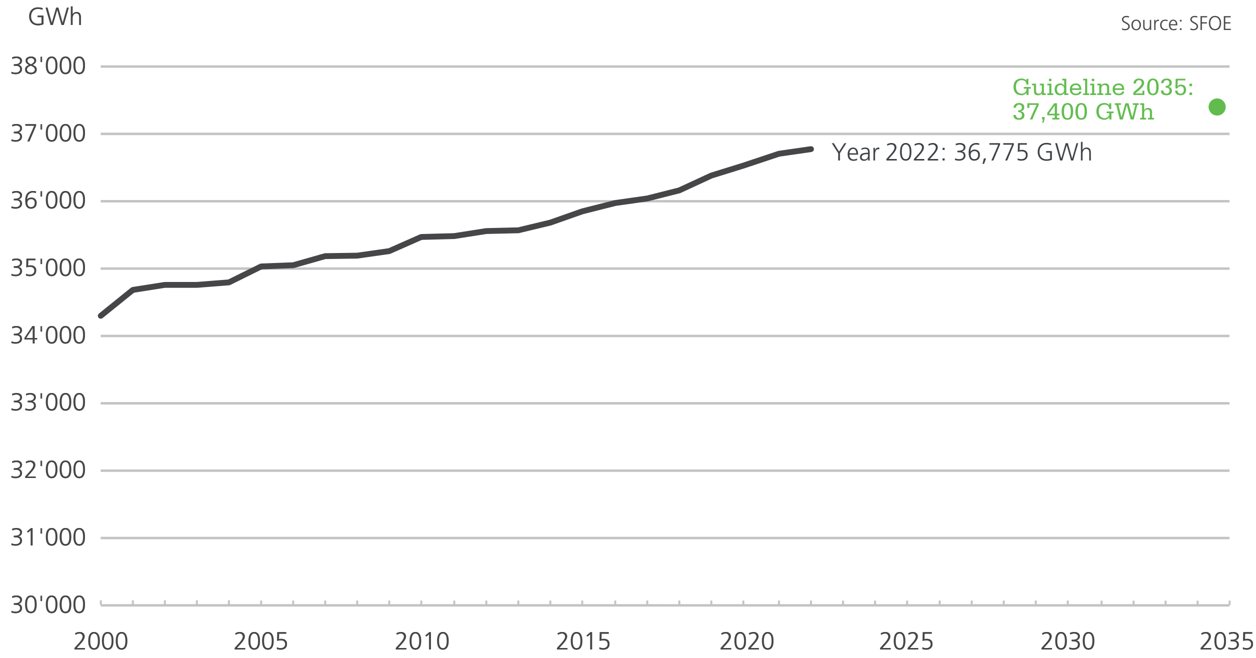


Figure 4: Development of the anticipated average production[3] of electricity from hydropower plants (in GWh) since 2000

Figure 4 (NB scale does not start at zero) shows that electricity production from hydropower plants has grown continuously since 2000; this growth is primarily due to the addition of new plants and the expansion and optimisation of existing facilities (see top chart). In 2022 (as at 1 January 2023), the anticipated average production was 36,775 GWh. In reference year 2011 (as at 1 January 2012), the figure was 35,488 GWh. To achieve the target, between 2011 and 2035 a net increase of around 1,900 GWh will be required. In the year under review, 67.3% of this increase had been attained. In 2022, the net increase versus 2021 was 67 GWh; since 2012 it has averaged 117 GWh per annum. To achieve the target by 2035, an average annual net increase of 48 GWh will be required. The Federal Act on a Secure Electricity Supply from Renewable Energy Sources sets a legally binding target of 37,900 GWh by 2035. In order to achieve this target value, an average annual net increase of 87 GWh will be required (source: SFOE, 2023b).

3 Anticipated average production including anticipated production from small hydropower plants <300 kW (according to statistics for hydropower plants in Switzerland, WASTA), excluding average energy requirement for all storage system pumps (for which an efficiency rate of 83 per cent is assumed) and excluding electricity required for recirculation. NB: The reference year, time series and chart were subsequently adjusted on the basis of an extraordinary correction by WASTA (cf. SFOE press release of 5 May 2022).

For more detailed indicators regarding **ENERGY CONSUMPTION AND PRODUCTION** see the full monitoring report.

GRID DEVELOPMENT

The reorganisation of the energy system required in line with Energy Strategy 2050 and the changing international environment are placing new requirements on the energy grids. Development of the electricity grids is crucial because they form the link between production and consumption. Their development is also the focus of the Federal Act on the Conversion and Expansion of the Electricity Grid (Electricity Grid Strategy) as part of Energy Strategy 2050, which has been in force since 2019 (Federal Council, 2016). Monitoring is currently focused 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, timely development of the electricity grid to guarantee the security of electricity supply. They provide standards for assessing the need to expand and modernise Switzerland's electricity grid, optimise the licensing procedures for line projects and the criteria for deciding whether to place cables underground or use overhead transmission lines. The regulations are intended to increase transparency in the grid planning process and improve acceptance of grid plans in general. The focus will be on the Swiss transmission network, which will have to guarantee the safe and sufficient transmission of energy fed in from domestic production centres, as well as imported energy over long distances to centres of consumption. In addition, it will have to compensate for fluctuating rates of energy fed in from renewable sources through imports and exports, as well as cope with the complementarity of the various types of power plant.

PROCESS AND PHASES OF A TRANSMISSION NETWORK PROJECT

PRELIMINARY PROJECT: As the basis for the sectoral plan procedure, national grid operator Swissgrid draws up a preliminary project with the key parameters of the grid plan and ensures that 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 as a rule with the initiation of the project, and ends when the application is submitted for the project to be incorporated in the sectoral plan for transmission lines. If a plan is not yet in either the preliminary or the construction project phase, and is thus in an early stage of planning, it is designated in the monitoring programme as a **project proposal.**

TRANSMISSION LINES SECTORAL PLAN: If a 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 can be initiated (*see below*). The Transmission Lines sectoral plan applies to the power lines network. The Swiss Federal Office of Energy (SFOE) is responsible for this sectoral plan, with the support of the Federal Office for Spatial Development (ARE). In the first stage of the sectoral plan procedure, a **planning zone** 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 defined, a decision is made as to which **transmission technology** is to be employed (overhead line or underground cable). The sectoral plan procedure begins when Swissgrid submits a corresponding application, and ends when the decision is taken on the planning corridor by the Federal Council in the corresponding detailed plan. This plan is binding for all authorities, which means they have to take it into consideration when approving the project and in any other spatial development activities.

CONSTRUCTION PROJECT: Once the planning corridor has been defined, Swissgrid's plan is developed within the scope of a detailed construction project. The company has to guarantee that the line will be

In April 2015, national grid operator 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 plans at the transmission network level, including Swissgrid's Strategic Grid 2025 (sections 1 to 10), as well as other projects, some of which are initiated by third parties (*cf. Figure 5*). The energy scenario framework legally introduced with the Electricity Grid Strategy forms a central basis for network planning. For grid operators the scenario framework constitutes a politically supported basis on which to determine the grid expansion requirements and to compile or update their own multi-year planning. The Federal Council approved the first such scenario framework in November 2022 and it is therefore binding for the authorities (Federal Council, 2022a). Swissgrid is currently updating its multi-year planning on the basis of the scenario framework and will subsequently submit it to ElCom for review. Swissgrid will then publish the Strategic Grid 2040 with the comprised projects, probably by the end of 2024. Owing to the changed legal basis in the area of power grids, the Federal Council also revised the conceptual part of the Transmission Lines Sectoral Plan from 2001 and adopted it in June 2023 (Federal Council 2023a). In addition, the Federal Council wants to shorten the planning process for power grid expansion and directly define the planning corridor in transition lines sectoral planning instead of first defining a planning area; it put this proposal out for consultation in June 2023 as part of the 'acceleration bill' for the construction of solar, wind and hydropower plants (Federal Council, 2023b+g). In November 2023, the Federal Council also held a debate on further measures to speed up the authorisation procedures for the conversion and expansion of the electricity grids. These include, for example, the optimisation of internal federal procedural and review processes for projects in the sectoral plan for transmission lines or the waiver of a sectoral plan procedure for the replacement or renovation of existing lines on existing routes.

4 cf. https://www.swissgrid.ch > Strategic Grid

constructed using the specified transmission technology and that the route lies within the defined planning corridor. In this monitoring procedure, the construction project phase begins as a rule with the definition of the planning corridor (which corresponds to the end of the sectoral plan phase) and ends when Swissgrid submits the planning approval application to the Federal Inspectorate for Heavy Current Installations (ESTI). In projects for which no sectoral plan is used, the start of the construction project is based on the corresponding standard of the SIA (Swiss Association of Engineers and Architects).

PLANNING APPROVAL PROCEDURE (PAP): Swissgrid now submits the detailed construction project to ESTI, together with the application for planning approval. This signals the start of the planning approval procedure. ESTI is responsible for examining the dossier and granting planning approval. In the planning approval procedure, projects are closely examined in order to verify that they comply with the relevant safety requirements and legal provisions, especially those of environmental and area planning legislation. At the same time, the procedure examines network projects to ensure that they are reconcilable with the interests of private individuals (property owners, local population). If the Inspectorate is unable to deal with all objections or settle disputes between the involved federal authorities, it forwards the documentation to the SFOE, which then proceeds with the planning approval procedure and grants planning approval provided the project is in conformity with the legal requirements. A decision is also made on any objections (e.g. concerning expropriation orders). The parties involved can appeal against such decisions to the Federal Administrative Court, and subsequently in certain cases to the Federal Supreme Court. If the SFOE approves the application for planning approval and no other objections are submitted within the legally binding deadlines, planning approval becomes final and Swissgrid can realise the transmission line project.

REALISATION: For monitoring purposes, the start of the realisation phase corresponds to the date of the legally binding planning approval decision, and ends when the facility is put into operation.

NETWORK PROJECT	DESCRIPTION AND MAIN AIMS	CURRENT STATUS[5]	PLANNED DATE OF OPERATION[6]
1. Chamoson–Chippis	▪ New 30km 380-kV overhead transmission line between Chamoson and Chippis ▪ Dismantling of almost 89km of power lines in Rhône plain ▪ Transfer of production from hydropower plants in Valais ▪ Improved connection between Valais and the Swiss and European ultra-high-voltage networks ▪ Contribution towards network security in Switzerland	In operation	Concluded in 2022 and in operation
2. Bickigen–Chippis (Gemmi line)	▪ Modernisation of Bickigen and Chippis substations and the existing 106km route by increasing the voltage to 380 kV ▪ Installation of a 220/380 kV coupling transformer in the Chippis switching facility ▪ Improved transfer of electricity production from Valais ▪ Contribution towards security of supply in Switzerland	FAC	2027
3. Pradella–La Punt	▪ Increase of the level on the existing 50km route from 220 to 380 kV ▪ Modification and expansion of Pradella switching system for 380 kV ▪ Elimination of existing bottleneck ▪ Contribution towards network security in Switzerland and Europe	In operation	Concluded in 2022 and in operation
4. Chippis–Lavorgo 4.1. Chippis–Mörel (Rhône Valley line) 4.2.Mörel–Ulrichen (Gommer line) 4.3. Chippis–Stalden 4.4. Airolo–Lavorgo	▪ Increase in voltage to 380 kV on 124km Chippis–Mörel–Lavorgo axis (Chippis–Stalden remains at 220 kV) ▪ Dismantling of existing lines over 67km ▪ Supplements main supply axis for Ticino ▪ Elimination of a critical supply bottleneck	4.1. SFOE planning approval procedure 4.2. Realisation (Mörel–Ernen)/in operation (Ernen–Ulrichen) 4.3. Realisation (Agarn–Stalden)/SFOE planning approval procedure (Chippis–Agarn) 4.4. SFOE planning approval procedure	2032
5. Beznau–Mettlen 5.1. Beznau–Birr 5.2. Birr–Niederwil 5.3. Niederwil–Obfelden 5.4. Mettlen–Obfelden	▪ Optimisation of existing 40km route by increasing voltage to 380 kV and upgrading of 24km stretch ▪ Elimination of structural bottlenecks ▪ Creation of necessary conditions for combining the flexibility of domestic hydropower with fluctuating energy from wind and photovoltaic plants	5.1. In operation 5.2. Preliminary project 5.3. Construction project 5.4. Preliminary project	2031
6. Bassecourt–Mühleberg	▪ Upgrading of the existing line over a length of 45km 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 supply security	Realisation	2023

Figure 5: Overview of network projects, status and proposed date of operation (status: 15 October 2023)

5 As at 15 October 2023

6 According to Swissgrid planning

NETWORK PROJECT	DESCRIPTION AND MAIN AIMS	CURRENT STATUS	PLANNED DATE OF OPERATION
7. Magadino	▪ Installation of transformers between the 220 kV and 380 kV grids ▪ The aim is to improve the transfer of energy ▪ generated in Maggia Valley by hydropower ▪ Contribution to security of supply in Ticino	Project proposal	2035
8. Génissiat–Foretaille	▪ Upgrading of (replacement of cable) the existing 220 kV twin lines over a length of 17km ▪ 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 of the existing 220 kV line to accommodate a future increase to 380 kV220-kV-Leitung auf rund 88 km auf 380 kV ▪ Important for the connection of new pump storage power plants to the 380 kV network and transfer of energy to the rest of Switzerland	9.1. Sectoral plan procedure 9.2. Preliminary project / Construction project[7]	2035
10. All'Acqua–Vallemaggia–Magadino	▪ New 220 kV line through the Maggia Valley ▪ Existing line built in the 1960s will be dismantled, thus lessening the impact on the protected areas in Upper Ticino ▪ Increase of capacity to convey energy generated in hydropower plants in Maggia Valley ▪ Greater security of supply in the southern Alps – today, production at power plants has to be curbed	Sectoral plan procedure	2035
11. Flumenthal–Froloo	▪ Replacement of around 33km of existing 145 kV distribution network lines with a new 220 kV ultra-high-voltage line, as part of the Strategic Grid ▪ New line will improve security of supply in the Greater Basel area and throughout Switzerland ▪ The project is intended to relieve the burden on developed areas between Flumenthal and Therwil – the new line is planned as far from settlements as possible ▪ After operation commences, the existing distribution network line will be dismantled	Sectoral plan procedure	2036
Nant de Drance connection NdD_1 Le Verney/Rosel–Bâtiaz NdD_2 Bâtiaz–Châtelard NdD_3 Châtelard–Nant de Drance	▪ Connection of Nant de Drance pump storage power plant to the ultra-high-voltage network ▪ Part of the strategic network in the initial Swissgrid network ▪ Contribution towards integration of new renewable energy sources	NdD_1 In operation NdD_2 In operation NdD_3 In operation	2022

Figure 5: Overview of network projects, status and proposed date of operation (status: 15 October 2023)

7 Project 9.2 Innertkirchen-Ulrichen (Grimsel line) is treated as a 'preliminary project' by Swissgrid as long as there are several variants (with / without bundling of the Grimselbahn railroad project). In the ES2050 monitoring, the project is referred to as a 'construction project' because the sectoral plan procedure corridor decision for the power line has been taken in principle.

NETWORK PROJECT	DESCRIPTION AND MAIN AIMS	CURRENT STATUS	PLANNED DATE OF OPERATION
ASR (Axe Stratégique Réseau) in the Geneva area	▪ Underground cabling of existing 220 kV line from Foretaille-Verbois over a length of about 4.5km alongside Geneva airport	Realisation	2025
Obfelden–Samstagern OS_1 Schweikrüti (Mast 46)–Kilchberg OS_2 Kilchberg–Wollishofen (Frohalp) OS_3 Wollishofen (Frohalp)–Waldegg OS_4 Obfelden–Waldegg	▪ Expansion and / or substitution of the existing 150 kV line between the Obfelden substation, the planned substation at Waldegg, and the Samstagern substation with a 380 / 220 kV line. ▪ Improvement to the energy supply of the consumer centres of Zurich and the region of Thalwil.	OS_1 Realisation OS_2 Construction project OS_3 Construction project OS_4 Preliminary project	2030
Grynau–Siebnen	▪ Replacement of existing 220 kV line with a 380 kW line (closing the gap in the 380 kV network) ▪ Improvement of supply security in the Lake of Zurich region / Linth plain and 1. Increase in import capacity from the north	SFOE planning approval procedure	2028
Amsteg–Mettlen AM_1 Abschnitt Lauerz AM_2 Eyschachen bei Altdorf	▪ AM_1: Swissgrid to place the line outside landslide area above Lauerz (SZ) ▪ AM_2: Swissgrid and Swiss Federal Railways to install ultra-high-voltage lines in the Uri valley floor. 2.This will relieve the burden on the developed areas in Attinghausen and the Werkmatt developed area in Uri.	AM_1 Construction project AM_2 In operation	2040
Airolo–Mettlen	▪ Bundling of infrastructure in the second tube of the Gotthard Road Tunnel ▪ Cabling of the existing 220 kV line from Airolo–Mettlen in the Gotthard sector planned over a length of 18km ▪ Important element of the north-south connection for electricity supply in Switzerland and Europe ▪ Dismantling of existing overhead line over a 23km stretch with more than 70 masts that currently traverse the Gotthard Pass and run through the Schollenen Gorge in the canton of Uri	ESTI planning approval application	2029
Marmorera–Tinzen	▪ Ultra-high-voltage line between Marmorera and Tinzen in the Albula region (canton of Graubünden) no longer corresponds to latest status of technology and needs to be replaced (220 kV as today). ▪ This line plays a significant role in the transfer of energy from Bergell hydropower plants to consumer centres in the central plateau.	Sectoral plan procedure	2032

Figure 5: Overview of network projects, status and proposed date of operation (status: 15 October 2023)

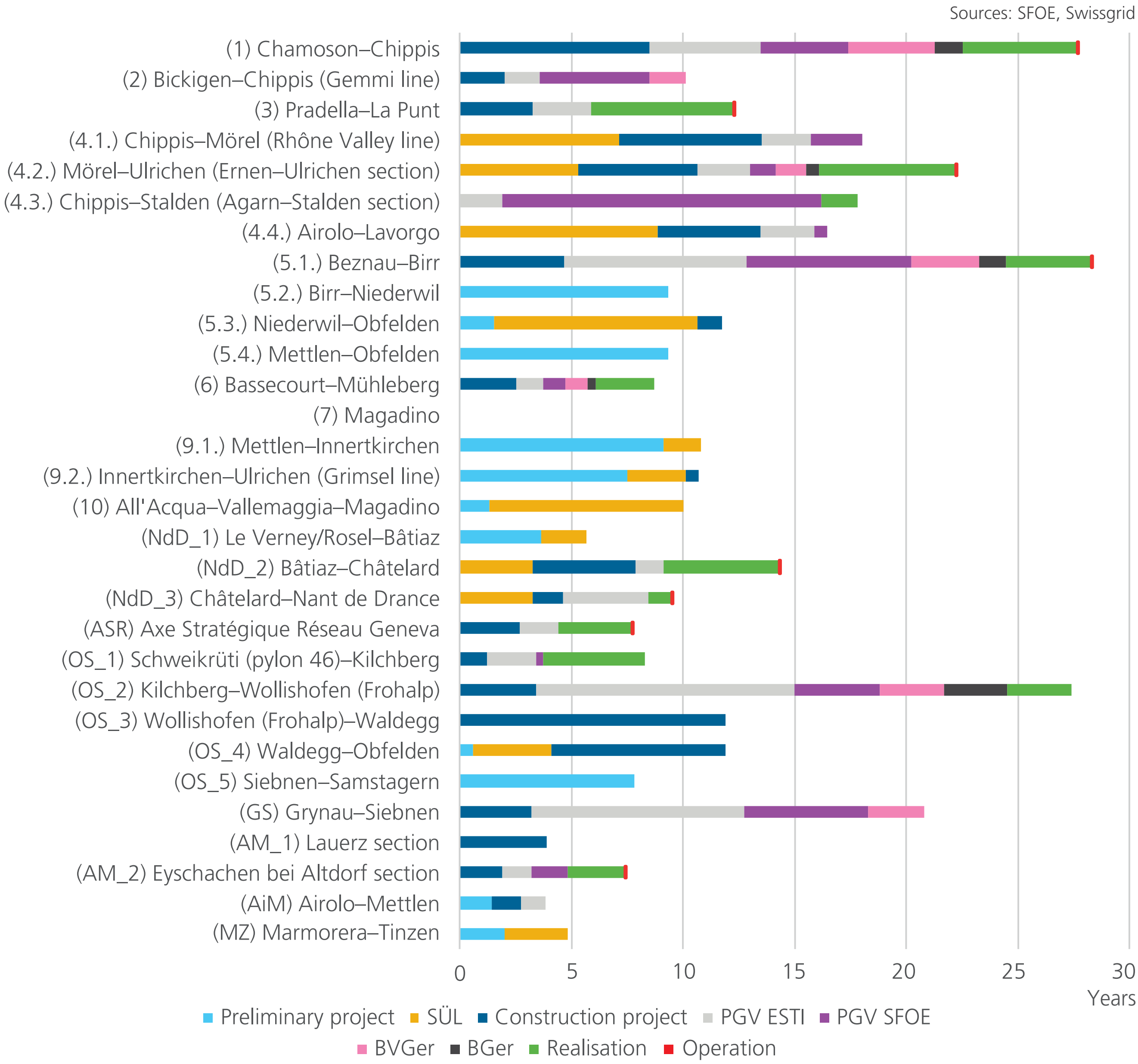


Figure 6: Accumulated duration of project phases of selected network plans in years at network level as at 15 October 2023 in years[8]

Figure 6 above shows the duration of projects, status and proposed date of operation for the network projects listed above. The duration is presented in a simplified manner in that any supplementary loops in the course of the project (i.e. if the procedure is returned to the SFOE after a decision by the Federal Administrative Court and/or the Federal Supreme Court) 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.

8 ***Remarks on method of use**: 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 planning approval procedure decision to the SFOE, half of the supplementary duration of the procedure is allotted to the planning approval procedure phase and half to the construction project phase.*

BRIEF DESCRIPTION OF THE PLANNING AND REALISATION STAGES OF EACH NETWORK PROJECT (STATUS: 15 OCTOBER 2023):

1. Chamoson–Chippis

Construction of the new line from Chamoson to Chippis in the canton of Valais was initiated before the Transmission Lines sectoral plan was developed, and the project was the subject of planning and approval phases for many years. An important milestone was reached in 2017: in its decision of 1 September 2017, the Federal Supreme Court dismissed the appeals against the ruling of the Federal Administrative Court of 14 December 2016 and confirmed the decision by the SFOE of 19 January 2015 concerning the planning approval procedure. Swissgrid then proceeded with the realisation of the new overhead transmission line project. The actual building work got under way in 2018. After four years of construction, Swissgrid put the line into operation at the end of September 2022. In some cases the dismantling of third party lines, which was ordered in connection with the project, is still outstanding, but this has no impact on the Chamoson–Chippis line.

2. Bickigen–Chippis

The Transmission Lines sectoral plan 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 impact on the area. After a construction project phase of around two years, the planning approval procedure commenced with an application to ESTI in mid-2015, and almost two years later the dossier was passed on to the SFOE. The SFOE granted planning approval in February 2022. However, various appeals were lodged against this decision with the Federal Administrative Court. Owing to the tense supply situation from the second half of 2022, the Federal Council allowed a temporary increase in voltage on the line to 380 kV between January and April 2023. Regular operation is scheduled 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 50km line between Pradella and La Punt. This will substitute the transfer of energy on the existing 220 kV overhead transmission line between Zernez and Pradella from the Ova Spin power plant. The energy generated at Ova Spin power plant will be transported over a 110 kV valley cable. No sectoral plan procedure was necessary because of the minimal impact on the area. The construction project and planning approval procedure phases each lasted about three years. The implementation phase started in mid-2016 and Swissgrid put the line into operation in November 2022.

4. Chippis–Lavorgo

Operation of the entire Chippis–Lavorgo network project is scheduled for 2032. It comprises several sub-projects, the current status of which is described below:

4.1. Chippis–Mörel (Rhône Valley line)

The project for the construction of the new line underwent a sectoral plan procedure and took almost six and a half years. The planning application procedure was initiated by ESTI in late March 2019. In June 2021, ESTI passed on the procedure to the SFOE. Within the scope of the planning approval procedure, the SFOE is examining the application from the canton of Valais, together with sectoral plan related issues in the Agarn–Mörel segment due to a new cabling study. Based on the insights gained from these issues, the SFOE had to request supplementary documents and studies from Swissgrid regarding a potential cabling of the line in the Chippis–Agarn segment (Pfyn forest).

4.2. Mörel–Ulrichen
Construction of the new line underwent planning and approval phases lasting several years; the section between Ernen and Ulrichen has been in operation since mid-October 2019; in the Mörel–Ernen section, the cabling study ordered by the Federal Supreme Court for the 'Binnegga–Binnachra–Hockmatta–Hofstatt' area (crossing the Binna) was submitted to the SFOE; the SFOE approved the overhead line version on 23 December 2016 and dismissed 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 Supreme Court, and the ruling is now legally binding. Construction of the line is in progress.

4.3. Chippis–Stalden
A planning approval procedure for the Agarn–Stalden segment took several years for the SFOE to process, and was concluded and became legally binding in the spring of 2022. It has since been in the realisation phase. This concerns a procedure under former legislation for which no sectoral plan procedure could be initiated. In 2012, it was determined in the sectoral plan procedure for the line from Chippis to Mörel that the Chippis–Agarn segment (Rhône Valley line) would have to be fed parallel to the Rhône Valley line through the Pfyn forest. Accordingly, the planning application for the construction of this segment was submitted to ESTI at the end of March 2019, together with the planning application for the Rhône Valley line. In June 2021, ESTI passed on the application to the SFOE. The planning approval procedure for the Chippis–Agarn section is therefore also pending with the SFOE.

4.4. Airolo–Lavorgo
The project for the construction of the new line underwent a sectoral plan procedure lasting almost nine years and the construction project planning took a full four years. At the end of April 2020, Swissgrid submitted the planning application dossier to ESTI, which transferred it to the SFOE in mid-September 2022. The SFOE suspended the ongoing planning approval procedure temporarily because various documents had to be revised.

5. Beznau–Mettlen
Operation of the overall Beznau–Mettlen project is planned for 2031. It comprises several sub-projects, the current status of which is described below:

5.1. Beznau–Birr
The line with partial underground cabling of 'Gäbihubel' at Riniken was initiated before the Transmission Lines sectoral plan was developed, and went through planning and approval phases lasting many years. A key milestone was reached in 2016: the SFOE's planning approval became final and the realisation got under way. Contrary to the original plan, construction work for the cable route could only commence in August 2018. Since then, work has progressed rapidly and on 19 May 2020, Swissgrid began to operate the line, including the cited partially cabled section in which a longer section of the 380 kV ultra-high-voltage line was placed underground.

5.2. Birr–Niederwil
The preliminary project for the section of the line was completed in September 2022. The next steps are currently being clarified.

5.3. Niederwil–Obfelden
The voltage increase was subject to a preliminary project phase lasting around 18 months and underwent a sectoral plan procedure lasting several years. A significant interim stage was reached in 2016 with the definition of the planning zone. In late August 2022, the Federal Council defined the planning corridor. Swissgrid subsequently initiated the development of the construction project.

5.4. Mettlen–Obfelden

This section is currently in the preliminary project phase. This was temporarily suspended to await the Federal Council's decision on the planning corridor and on the transmission technology (*cf. 5.3*).

6. Bassecourt–Mühleberg

The Bassecourt–Mühleberg ultra-high-voltage line was licensed by ESTI to operate at 380 kV in 1978, but it has been operating at 220 kV to date. No sectoral plan procedure was required for the envisaged increase in voltage because of the minimal impact the project would have on the area. After a construction project phase lasting about two and a half years, Swissgrid submitted the planning application 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 lodged appeals against this decision with the Federal Administrative Court. In its ruling of September 2020, the latter dismissed the objections it examined. The ruling was referred to the Federal Supreme Court, which in turn dismissed the objections in its ruling dated 23 March 2021. Owing to the tense supply situation from the second half of 2022, the Federal Council allowed a temporary increase in voltage on the line to 380 kV between January and April 2023. Regular operation is scheduled to resume by the end of 2023.

7. Magadino

A preliminary study proposing several options is currently being compiled in order to subsequently initiate the preliminary project. According to Strategic Grid 2025, operation was originally foreseen for 2018, but according to updated plans it is now planned for 2035.

8. Génissiat–Foretaille

Swissgrid has adapted the scope of the project and reduced it to eliminate the bottlenecks between France and Switzerland. The original plan to strengthen the Foretaille–Verbois line on the Swiss side with a transmission line facility 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

Operation of the overall project is currently planned for 2035. It comprises two sub-projects, the current status of which is described below:

9.1. Mettlen–Innertkirchen

This section of line was in the preliminary project phase for a number of years. At the end of June 2020, Swissgrid applied to the SFOE to initiate a sectoral plan procedure for a new line into Innertkirchen substation. However, at the beginning of June 2021 the project was cancelled at the request of the applicant because the line is now to be integrated into the sectoral plan procedure for the complete stretch. The sectoral plan procedure for the complete stretch started in late June 2021. The SFOE announced the planning area in mid-November 2022. In May 2023, Swissgrid submitted the documents for the second phase of the sectoral plan procedure to the SFOE. This phase, which has been ongoing since then, involves defining the planning corridor.

9.2. Innertkirchen–Ulrichen (Grimselleitung)

Upgrading of the existing 220 kV line to 380 kV between Innertkirchen and Ulrichen (Grimsel line) along its full length is a key element in Network Strategy 2025. Swissgrid applied for a sectoral plan procedure for this line at the beginning of July 2020. The Federal Council determined two potential planning corridors in February 2022: if the Grimselbahn project is realised on time, the line will be bundled with the rail project and mounted in a cable tunnel running parallel to the railway tunnel; alternatively, the line will be laid in a cable tunnel between Innertkirchen and Oberwald. In both cases the line between Oberwald and Ulrichen will be an overhead line.

10. All’Acqua–Vallemaggia–Magadino

Planning of the line project in the All’Acqua–Maggiatal–Magadino area (and of the above-mentioned sub-project 4.4. Airolo–Lavorgo) is based on a comprehensive study carried out in 2013 concerning the reorganisation of the ultra-high-voltage network in Upper Ticino to coordinate the refurbishment and modernisation of lines in coordination with spatial planning. Subsequently, the preliminary project phase was prepared, and the sectoral plan procedure was initiated in 2015. In 2016, a significant stage in the project was attained when the planning area was defined. In view of its length, the project was divided into three segments for the implementation of the sectoral plan procedure so that it could be carried out in manageable stages. However, the definition of the planning corridor on the Avegno to Magadino stretch has been delayed due to the question concerning the location of the Magadino substation, which is in the perimeter of the 'Piano di Magadino' biosphere reserve. The hearing is currently under way for all three stages of the planning corridor proposed by the SFOE, and a decision on it is expected from the Federal Council in March 2024. Operation of the new 220 kV line is planned for 2035.

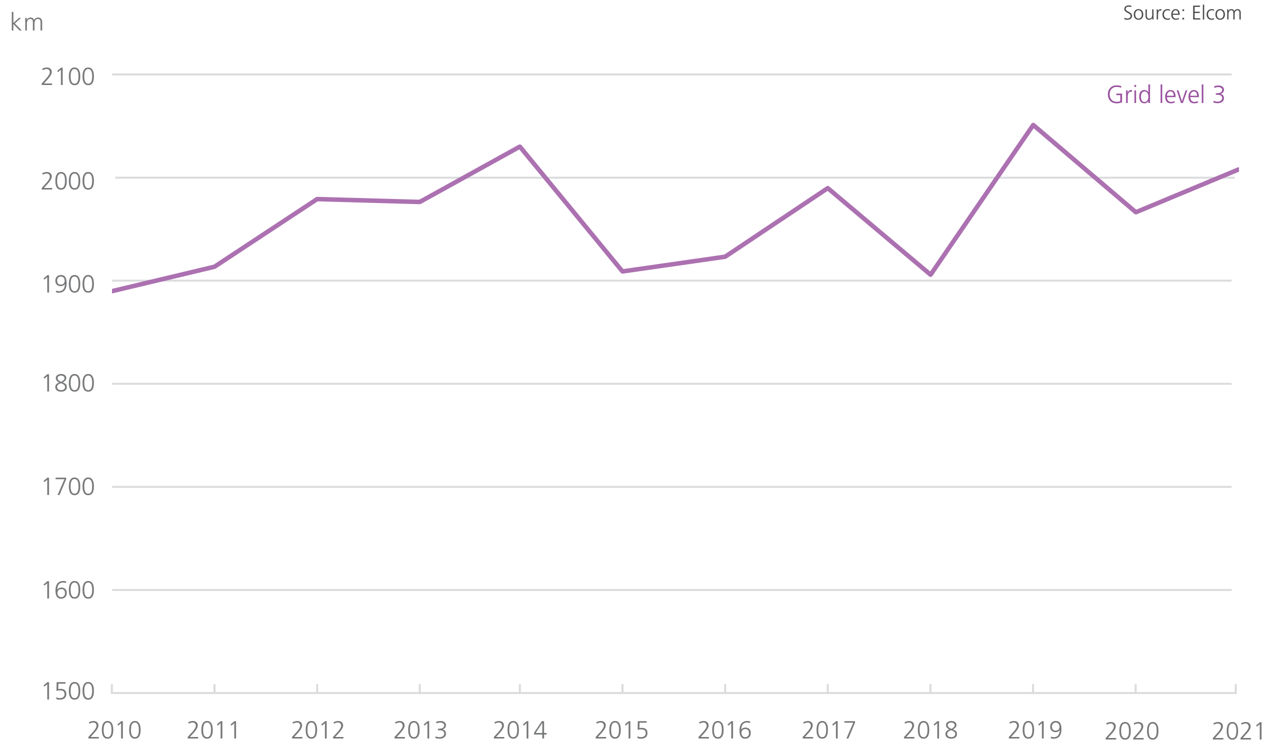
11. Flumenthal–Froloo

The preliminary project for the new 220 kV transmission line between Flumenthal (SO) and Froloo (in the commune of Therwil, BL) was launched in 2018. In early April 2022 Swissgrid submitted an application to the SFOE to start the sectoral plan procedure. Operation is planned for the end of 2036.

(Source: SFOE / Swissgrid, 2023 / Swissgrid 2015)

↗ Description of other selected projects:
full version of the monitoring report.

UNDERGROUND CABLING



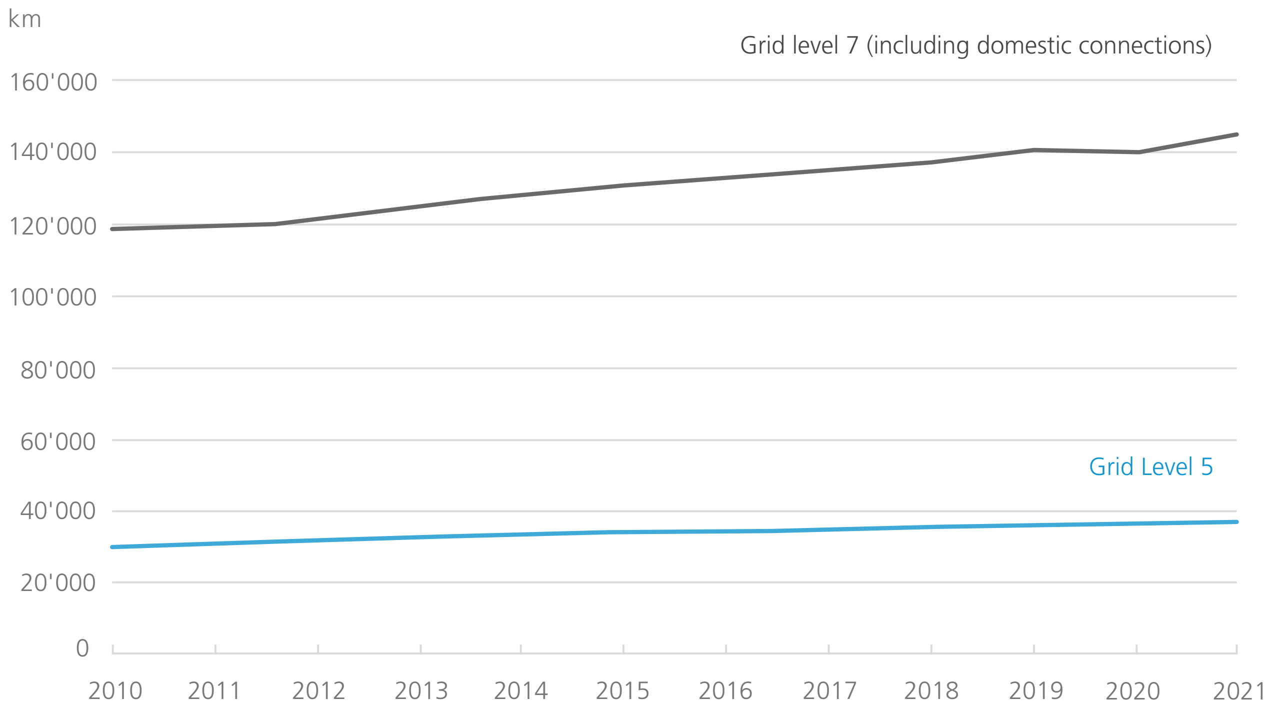


Figure 7: Inventory of underground cabling in the distribution network (in kilometres)

UNDERGROUND CABLING

Laying electricity cables underground can contribute to greater acceptance of line construction by the population so that projects can be completed more quickly. Furthermore, as a rule the quality of the landscape is improved and the risks of electrocution and of birds colliding with installations can be avoided. However, whether to construct a transmission line (network level 1) as an overhead line or place it underground has to be decided on the basis of objective criteria[9] on a case by case basis. In accordance with the Federal Act on the Conversion and Expansion of the Electricity Grid (Electricity Grid Strategy), distribution network lines (network levels 3, 5 and 7) should be placed underground provided a specific cost factor is not exceeded (cost overrun factor). For this reason, the monitoring process primarily observes the development of the use of underground cabling at the distribution network level. This also provides information concerning the impact of the cost overrun factor.

More cables have been placed underground at all network levels in the distribution network to varying extents since 2010, as shown in **Figure 7**. Generally speaking, there is more underground cable in use at lower network levels; network level 7 in particular consists almost entirely of underground cable. At network level 5 too, cabling is widespread, especially in urban areas. In contrast, only a slight increase in the number of underground lines can be observed at network level 3, and to a lesser degree than at all other levels (*cf. purple curve in the upper graph with differing scale*). The trend towards underground cabling is not so pronounced at this level. In addition, between 2014 and 2015, between 2017 and 2018 and between 2019 and 2020, declines in underground cabling were observed, the reasons for which are not clear. However, in 2021 the degree of cabling increased again compared with the previous year. The total length of the three transmission network levels (overhead transmission lines and cables, including domestic connections) is 207 kilometres, of which around 89% consists of underground cables. To date, very few lines have been laid underground in the transmission network (network level 1), which has a total length of 6,700 kilometres. However, in the case of the 'Beznau–Birr' line (see above) with partial cabling at 'Gäbihubel' near Bözberg/Riniken, a longer section (around 1.3 kilometres) of a 380 kV ultra-high-voltage line was laid in the ground and put into operation. As part of the connection of Nant de Drance pump storage power plant, the 'Bâtiaz–Le Vernay' section was also laid underground. The new 2 x 380 kV cable replaced the existing 220 kV overhead line that crossed the Rhône Valley over a distance of 1.2 kilometres. This section has been in operation since early April 2022. A further underground cable project involving a transmission line concerns the replacement of the existing 220 kV line over a length of 4.5 kilometres for the ASR project in the canton of Geneva. In addition, the 220 kV ultra-high-voltage line between Airolo and Mettlen is to be cabled in the Gotthard road tunnel between Airolo and Göschenen over a length of around 18 kilometres (sources: ElCom, 2023a/SFOE/Swissgrid, 2023).

9 cf. SFOE transmission lines evaluation model: Overhead lines versus underground cables (admin.ch)

SMART METERS

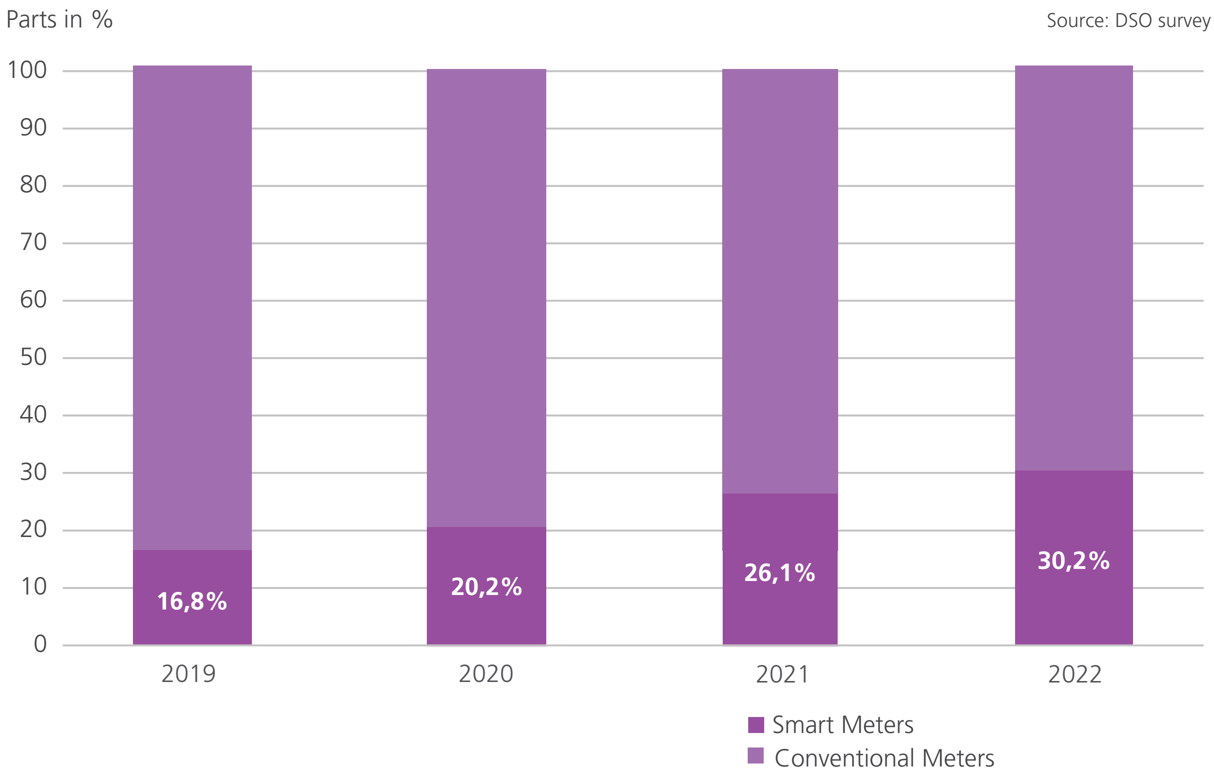


Figure 8: Share of smart meters compared with conventional meters [10]

The increasing proportion of electricity produced by decentralised providers is leading to many challenges for the electricity grid. In addition to renewal and expansion, the creation of a smart grid is an important priority of Energy Strategy 2050. Using information and communications technology, integrated data and electricity networks with innovative functions are to be developed. This means for example that intelligent control systems can balance out fluctuations in electricity production from renewable energy, as well as in electricity consumption. Smart grids guarantee secure, efficient and reliable system and network operation and make a contribution to minimising the extent of the required network expansion. The indicators below show the development of key components of this smart grid: smart meters, voltage control instruments (transformation) and new grid-friendly control and adjustment instruments (flexibility).

Smart meters are a central component of intelligent networks. Their introduction is regarded as an important initial step towards creating smart networks. The Electricity Supply Ordinance therefore specifies the applicable minimum technical requirements and calls for the introduction of such systems. After an interim period of 10 years from the entry into force of the Electricity Supply Ordinance at the beginning of 2018 (i.e. by the end of 2027), 80% of all metering systems in a network zone will have to comply with the corresponding requirements; the remaining 20% may remain in use until they no longer function. According to information from distribution system operators, in 2022 there were approximately 1,750,150 smart meters installed and in operation throughout Switzerland. This represents a proportion of around 30%, as shown in **Figure 8**. The proportion has constantly increased during the past few years (source: DSO, 2023).

10 Data based on survey of distribution network operators (plausibility check only possible to a limited extent).

For more detailed indicators regarding
GRID DEVELOPMENT
see the full monitoring report.

SECURITY OF SUPPLY

During the transformation of the energy system, with the increase in the use of renewable energy, enhanced energy efficiency and increasing decarbonisation and electrification, special attention has to be paid to the security of supply. One of the aims of Energy Strategy 2050 is to guarantee the currently high level of supply security over the long term. The issue of supply security is also enshrined in the energy article in the Federal Constitution, as well as in the Energy Act. By categorising energy sources (diversification) and dependence on foreign supplies, the monitoring process observes indicators which characterise significant aspects of the development of supply security from the overall energy perspective. With the phasing out of nuclear power, the increase in the use of renewable energies, enhanced energy efficiency and the longer-term decarbonisation and electrification of the energy system, the electricity sector is also a centre of focus.

DIVERSIFICATION OF THE ENERGY SUPPLY

Figure 9 shows that oil products (combustibles and motor fuels, including aircraft fuel in international air traffic) accounted for over 45% of final energy consumption in 2022. Electricity accounted for around 27% of overall end energy consumption and gas around 13%. The share of oil-based combustibles fell by around 13 percentage points between 2000 and 2022 as a result of the replacement of oil-fired heating systems and efficiency increases in buildings. Following a decline as a result of the COVID-19 pandemic, the share of oil-based motor fuels saw a sharp year-on-year increase in 2022 of 4% , but is still 1% lower than in 2000. In addition, the milder winter weather, the higher energy prices due to Russia's military intervention against Ukraine, and the federal government's energy-saving awareness campaign impacted the shares of oil-based combustibles in particular (–2%, year-on-year) and gas (–2%). In the longer term (between 2000 and 2022), the significant decrease in the share of oil means the proportions of all other energy sources have increased (apart from coal): gas (+2.3%), electricity (+4.6%), wood and charcoal (+2.1%), and other forms of renewable energy (+3.5%) and district heat (+1.2%). Overall, the energy supply is broadly diversified, which contributes towards the high degree of supply security in Switzerland (source: SFOE, 2023a).

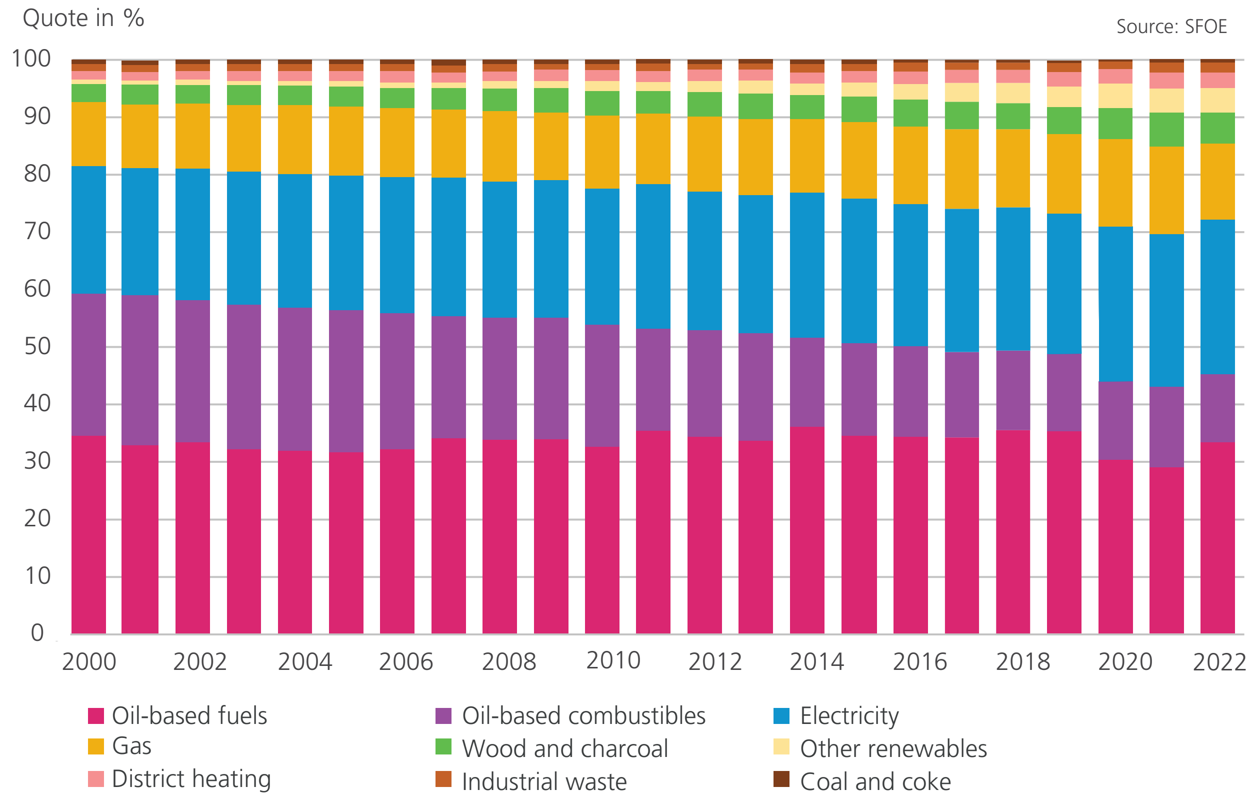


Figure 9: Diversification of the energy: proportion of energy sources to end energy consumption

DEPENDENCY ON IMPORTS

Figure 10 shows that the import surplus tended to rise between 2000 and 2006, after which it fell, though with occasional strong fluctuations. At the same time, domestic production has tended to increase since 2000. Owing to the long periods of drought in 2022, which led to a sharp decline in hydropower production, domestic generation declined significantly year-on-year for the first time since 2011. Nevertheless, hydropower remains the most important domestic energy source, while the other renewable energy sources are showing constant growth. Gross imports were composed in the main of fossil fuels and nuclear fuels. As indicated by the black curve on the graph, the proportion of imports to gross energy consumption (dependency on imports) grew from 2000 to 2006 and then declined until 2021. Dependency on imports increased again in 2022, notably due to the decline in domestic production and the sharp increase in aircraft fuel imports, and has remained at a high level. In 2022 the proportion of imports to gross energy consumption was 73.3% (2021: 70.2% and 2006: 81.6%). This ratio has to be interpreted with caution, because there are a number of different factors that influence it. In general it may be stated that energy efficiency measures that reduce consumption, and thus imports of fossil energy in particular, and the expansion of domestic energy production from renewable sources, lessen the dependency on imports and have a positive effect on supply security, (Sources: SFOE, 2023a/FSO/FOEN/ARE, 2023)

Source: SFOE

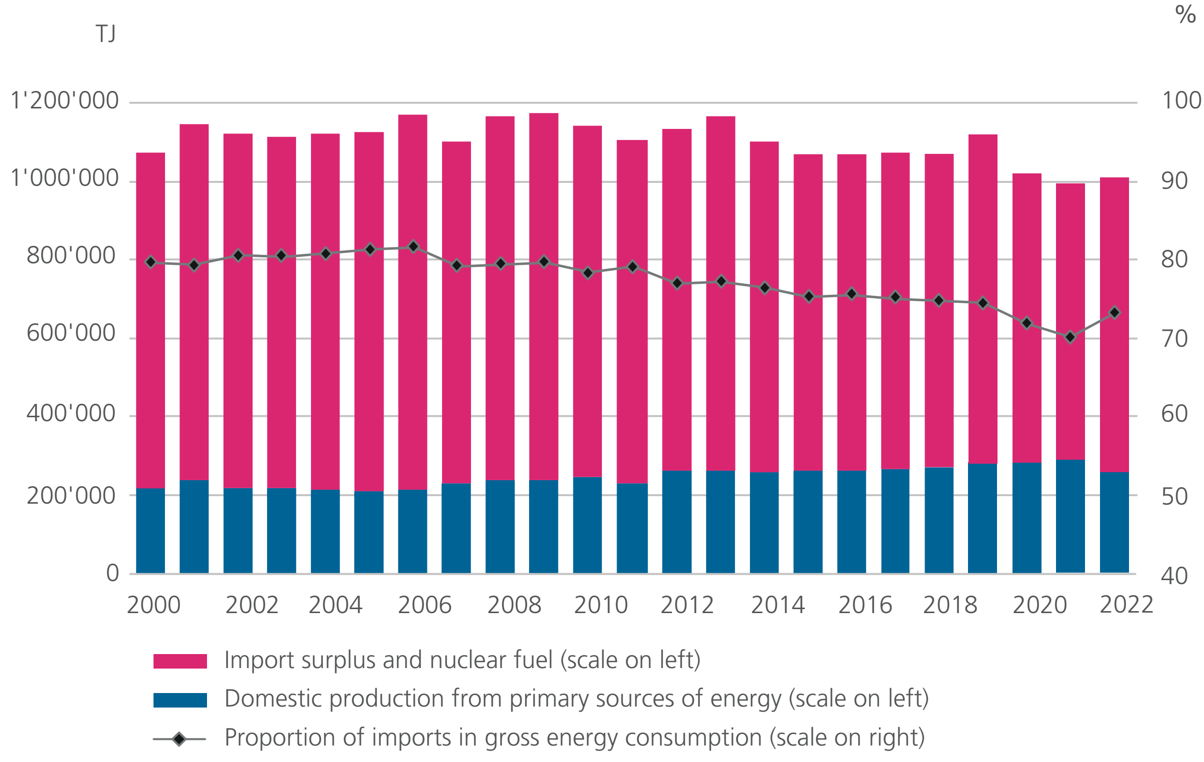


Figure 10: Import surplus and domestic production (in TJ) and proportion of energy imports to gross energy consumption (in %)

ELECTRICITY SUPPLY SECURITY: SYSTEM ADEQUACY AND WINTER PRODUCTION CAPACITY

The phasing out of nuclear energy within the scope of Energy Strategy 2050 and the longer-term decarbonisation of the energy system represent major challenges for Switzerland's supply security. The Federal Act on a Secure Electricity Supply from Renewable Energy Sources sets out various measures to improve security of supply in the longer term. The measures include additional funding for the expansion of winter production (primary hydropower storage plants and Alpine solar plants), the creation of an energy reserve and increased use of renewable energy (Federal Council, 2023). Russia's military intervention against Ukraine and the associated fears of a gas shortage have made short- and medium-term security of supply a current focus. The Federal Council has already enacted various measures and mandated the SFOE in summer 2022 to compile a study on short-term system adequacy for the winter of 2022/23. ElCom also updated its analyses on security of supply to 2025.

In Switzerland, too, securing the electricity supply is based on the interaction between power plant capacities and the electricity grid, which facilitates the transmission and distribution of the produced energy. The electricity grid supplements the domestic power plant capacities with imported volumes and are of equal importance with respect to supply security. Switzerland is highly interconnected and is therefore increasingly dependent on the circumstances in neighbouring countries. Because the circumstances are liable to change over the course of time due to strategic reorientation in other countries (in particular within the EU), comprehensive periodical analyses of system adequacy have to be carried out in order to accurately assess the supply security situation. System adequacy analyses are based on a comprehensive modelling of the supply situation which reflects the strategic orientation in the fields of production, consumption and the necessary grid infrastructure. Like all simulations, the modelling methods underpinning SA studies are subject to limitations and simplifying assumptions. The underlying data assumptions about European and Swiss system developments and their uncertainties – particularly with regard to the long term – are of key significance. The resulting simulations are consequently not predictions, but indicators of the developments that are considered critical from a systemic perspective.

Study on short-term system adequacy (winter 2022/23): On account of the tense supply situation as a result of Russia's military intervention against Ukraine, an SA study was conducted for the winter of 2022/23 on behalf of the SFOE and in conjunction with ElCom and the FONES. The study concluded that the security of Switzerland's electricity supply was not at risk in the winter of 2022/23 but that shortages could not be ruled out. In principle, this study still applies to the winter of 2023/24, provided current developments do not give rise to any new stress factors. Energy consumption in the likeliest scenarios (*see below*) can be covered by the measures put in place by the Federal Council. A hydropower reserve will secure energy supply at the critical stage towards the end of winter. The provision of a temporary reserve power plant in Birr (AG) and other reserve power plants and emergency generators can plug any gaps in power supply. The other measures, such as increasing capacities in the transmission grid, the backstop for system-critical power companies, and the temporary reduction in the residual flow in hydropower plants, will further strengthen winter supply. Voluntary efforts by businesses and individuals to use less energy as part of the energy-saving campaign also play an important part.

- **The reference scenario** assumes that French nuclear reactor availability was down by 35% in the winter of 2022/23, but that Europe-wide there was sufficient gas for power generation. The calculations show that in this scenario, there is enough energy from domestic and foreign production to cover Switzerland's electricity demand. This presupposes, however, that market-based electricity trading in Europe continues to function and that mutual support is guaranteed in shortage situations.

- **The gas shortage scenario** assumes that natural gas availability for power generation decreases by about 15% throughout Europe. In by far the majority (87%) of the approximately 2,400 simulations conducted for this scenario, it does not result in an electricity shortage in Switzerland. In 8% of the simulations, the shortfall in electricity equates to more than a winter day's consumption (ENS: Energy Not Served), which is around 170 GWh. In 5% of the sim-

ELECTRICITY SUPPLY SECURITY: SYSTEM ADEQUACY AND WINTER PRODUCTION CAPACITY

ulations, the shortfall in electricity equated to more than two-and-a-half days of winter consumption.

- **In the nuclear power outage scenario**, 50% of French nuclear reactors as well as the Swiss nuclear power plants in Leibstadt and Beznau 1 experience an outage during the winter. This scenario may lead to regional bottlenecks, but they would not extend to Switzerland thanks to its hydropower availability and its sufficient import capacities from other neighbouring zones.

- **The extreme scenario** involving a combination of a Europe-wide gas shortage and a complete outage of all Swiss nuclear power plants would have a significant impact on Switzerland. This – albeit highly unlikely – scenario in the winter months would result in an average electricity shortfall of just under six typical winter days' consumption. (Source: SFOE/ElCom/FONES, 2022)

In late 2022, the SFOE published an SA study with a **timeframe up to 2040**. Based on the Energy perspectives 2050+, which also takes account of the net zero climate target by 2050, an assessment of the medium- and long-term security of electricity supply is being carried out in this study. Other factors were also considered, including the possibility of not having an electricity agreement. However, for time reasons, a potential gas shortage was not considered (*see above: short-term SA study*). The study showed that three dimensions are crucially important to Switzerland's security of supply: hydropower, import capacity and wider developments in Europe. If the interaction between the first two dimensions is good, even major shortages in Switzerland or in Europe will remain non-critical. The other results are summarised below.

- With the expansion of renewable energies, the European electricity supply system will become increasingly dependent on weather conditions. From a purely physical perspective and based on the assumed scenarios, dependence on weather conditions could lead to a maximum of 250 GWh of uncovered electricity consumption in Switzerland in 2040. From a market perspective, however, there are no problems for Switzerland as long as it is well integrated into the overall European system.

- If cooperation with Europe is guaranteed (electricity agreement or technical contracts that allow exchange capacities to be maintained at their current level), the calculations do not show any shortages from the market perspective in the years ahead either, unless Swiss nuclear power plants are not available.

- In the absence of cooperation with Europe, Switzerland faces a risk of supply shortages in certain weather patterns, if the current framework conditions (as at 2019) are not adapted for expansion. The impact of the Federal Act on a Secure Electricity Supply from Renewable Energy Sources and the Federal Act on Urgent Measures for the Short-Term Provision of a Secure Electricity Supply in winter, are not taken into account here.

- If the framework conditions for expansion improve, however, there will not be any shortages, even without cooperation. Shortages are only a threat in the event of very strong electrification in individual, unfavourable weather conditions.

- If, in addition to the limited exchange capacities (in other words in the absence of cooperation), major incidents were to occur in Switzerland or in neighbouring countries (e.g. power plant outages), this would have a significant impact on Switzerland. In a situation such as this, any additional domestic energy helps, where in particular the flexibility of the available Swiss hydropower is crucial as the additional energy can be optimally integrated in the system through the use of pumps or modified power plant schedules. (Source: University of Basel/ETHZ/Consentec, 2022).

ElCom updated its analyses on medium- and long-term security of electricity supply in 2023. On the one hand, it instructed Swissgrid to recalculate its analysis on **security of supply 2025** with adapted

ELECTRICITY SUPPLY SECURITY: SYSTEM ADEQUACY AND WINTER PRODUCTION CAPACITY

scenarios. On the other, ElCom updated its **calculations on winter production capacity up to 2035** with new projections on the operating lives of nuclear power plants, electricity demand and the expansion of renewable energies.

In the SA study for 2025 the stress scenarios were modified compared with the most recent analysis from 2021[11] to reflect the recent experiences in connection with Russia's military intervention against Ukraine and the extremely low availability of French, nuclear power plants. The assumptions about the availability of domestic power generation were also adapted (in particular operation of Beznau I and II beyond 2025).

In the updated reference scenario, none of the simulations gives rise to supply issues. Even in the evaluated stress scenario (with a gas shortage and low nuclear power plant availability), while no shortages occur, they cannot be ruled out. In a worst case scenario, an electricity shortfall of around 500 gigawatt hours (GWh) would be expected. If the relatively high assumed redispatch (power plant interventions to stabilise the grid) in the simulation is reduced by half, the electricity shortfall decreases to 113 GWh.

For the longer-term outlook to 2030 and 2035, ElCom also updated its winter production analysis. The focus here is on power generation and domestic demand, while developments abroad and therefore import opportunities are excluded. The analysis thus provides simplifying parameters for the longer-term resilience of Switzerland's supply. The analysis includes two indicators. As in ElCom's last white paper, one indicator is Switzerland's import requirement in the winter months. The other is the number of days during which Switzerland could be self-sufficient towards the end of the winter when the seasonal storage facilities are already largely empty, if imports were temporarily unavailable due to supply bottlenecks in Europe.

ElCom then defines scenarios on the basis of various projections from recognised institutions as well as policy objectives. The benchmarks for minimum resilience are the winter import limits defined by Parliament (5,000 GWh or 20% of the average power consumption during the winter) or at least 22 days of self-sufficiency (approximate current value). Both indicators illustrate the very high level of uncertainty around the evolution of supply resilience: in order to achieve the targets (assuming NPP operating life of 60 years), between 0 and 1,400 MW of reserves with continuous output capacity would be needed by 2030 and between 0 and 2,100 MW by 2035, depending on the scenario.

On the basis of these two studies, ElCom recommends thermal reserve power plant capacity of at least 400 megawatts (MW) for 2025, and 700 to 1,400 MW from 2030. Because of the high level of uncertainty, a step-by-step approach makes sense in order to be able to extend reserves if needed. Currently, the following supplementary reserves are available until spring 2026: reserve power plant Birr (AG), 250 MW capacity; reserve power plant Corneaux 1 (NE), 36 MW capacity; gas-fired combined-cycle power plant in Monthey (VS), 50 MW capacity; pooled generators, approx. 110 MW capacity. In late July 2023, the SFOE launched the first tender process for reserve power plants after 2026. The tender covers a volume of 400 MW. (Sources: Swissgrid, 2023/Elcom, 2023c)

11 Frontier Economics (2021): Analysis of electricity market cooperation between Switzerland and the EU.

For more detailed indicators regarding
SECURITY OF SUPPLY
see the full monitoring report.

EXPENDITURE AND PRICES

In addition to safety and environmental compatibility, a further significant dimension for a sustainable energy supply is economic viability. Energy Article 89 in the Federal Constitution and Article 1 of the Energy Act specify that a sufficient, diversified, safe, economic and environmentally compatible energy supply must be assured. The purpose of Energy Strategy 2050 is to successively reorganise Switzerland's energy system as a consequence of the phasing out of nuclear energy and other significant changes in the energy environment, without jeopardising the international competitiveness of Switzerland as a business location. The focus in this area is therefore on monitoring final consumer expenditure for energy and energy prices.

FINAL CONSUMER EXPENDITURE FOR ENERGY

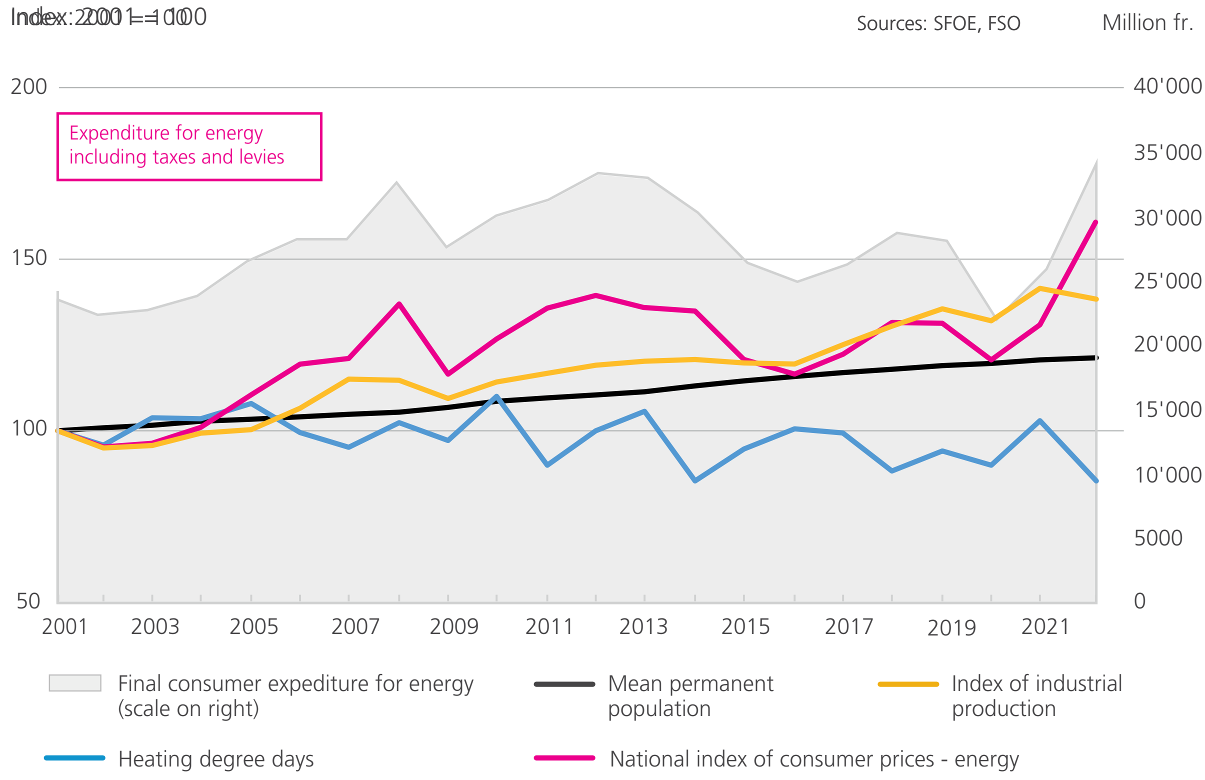


Figure 11: Final consumer expenditure for energy (estimates in million Swiss francs) and significant influencing factors (indexed)

Figure 11 shows the development of final consumer expenditure for energy in Switzerland, which in 2022 amounted to around CHF 34.1 billion. After reaching a low in 2020 at CHF 22 billion, expenditure rose sharply in 2021 (to around CHF 25.9 billion) and in particular in 2022. The increase in expenditure was driven by rising prices; the sub-index of the Swiss Consumer Price Index that tracks energy prices, rose by 22% in the space of a year. Particularly marked was the increase in expenditure for the predominantly fossil combustibles and fuels (oil-based combustibles, motor fuels, gas)[12] – these three sources of energy accounted for around two thirds of total expenditure for energy, at CHF 22.6 billion. Around CHF 10.5 billion was spent on electricity, and the remainder on solid combustibles and district heat (CHF 570 million)[13]. Between 2001 and 2021 expenditure on energy increased on average by 0.4% a year. In 2022, which was an exceptional year, 31% or CHF 8.1 billion more was spent on energy than in the previous year, while the annual growth rate for energy expenditure increased to 1.6% between 2001 and 2022. During the same period, growth was reported in industrial production (1.5% per annum), the population (0.9% per annum) and the Swiss consumer price index for energy (2.2% per annum). What is noticeable here 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: this behaviour depends more on

FINAL CONSUMER EXPENDITURE FOR ENERGY

other existing and comparatively constant factors, such as the number of vehicles and dwellings. This constitutes an example of low, short-term price elasticity. Over the course of time, a significant increase in final consumer expenditure and energy prices is apparent in 2008, followed by a decline in 2009. 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. As a consequence of the COVID-19 pandemic, less energy was consumed in 2020, particularly motor fuel, which, together with low prices, resulted in exceptionally low expenditure for energy. The volumes consumed and expenditure increased again in 2021, while 2022 was characterised by the sharp rise in prices and the associated high expenditure – this is despite the fact that the amount of energy consumed for heating purposes (mainly gas and heating oil) and electricity declined, partly due to the milder weather (fewer heating degree days). Improved energy efficiency measures can reduce energy consumption and therefore final consumer expenditure (sources: SFOE, 2023a / FSO, 2023a).

12 In 2022, 3.4% of consumed petrol and diesel were of biogenic origin, i.e. they are not oil products (SFOE press release dated 11 June 2023). The share of domestic biogas fed into the grid amounted to 1.3% of total gas consumption in 2022 (SFOE press release of 22 June 2023).

13 In addition to expenditure for energy and transport, all taxes and levies are included in energy expenditure (CO_2 levy, oil tax, value added tax, etc.).

ENERGY PRICES FOR SECTORS IN INDUSTRY IN INTERNATIONAL COMPARISON

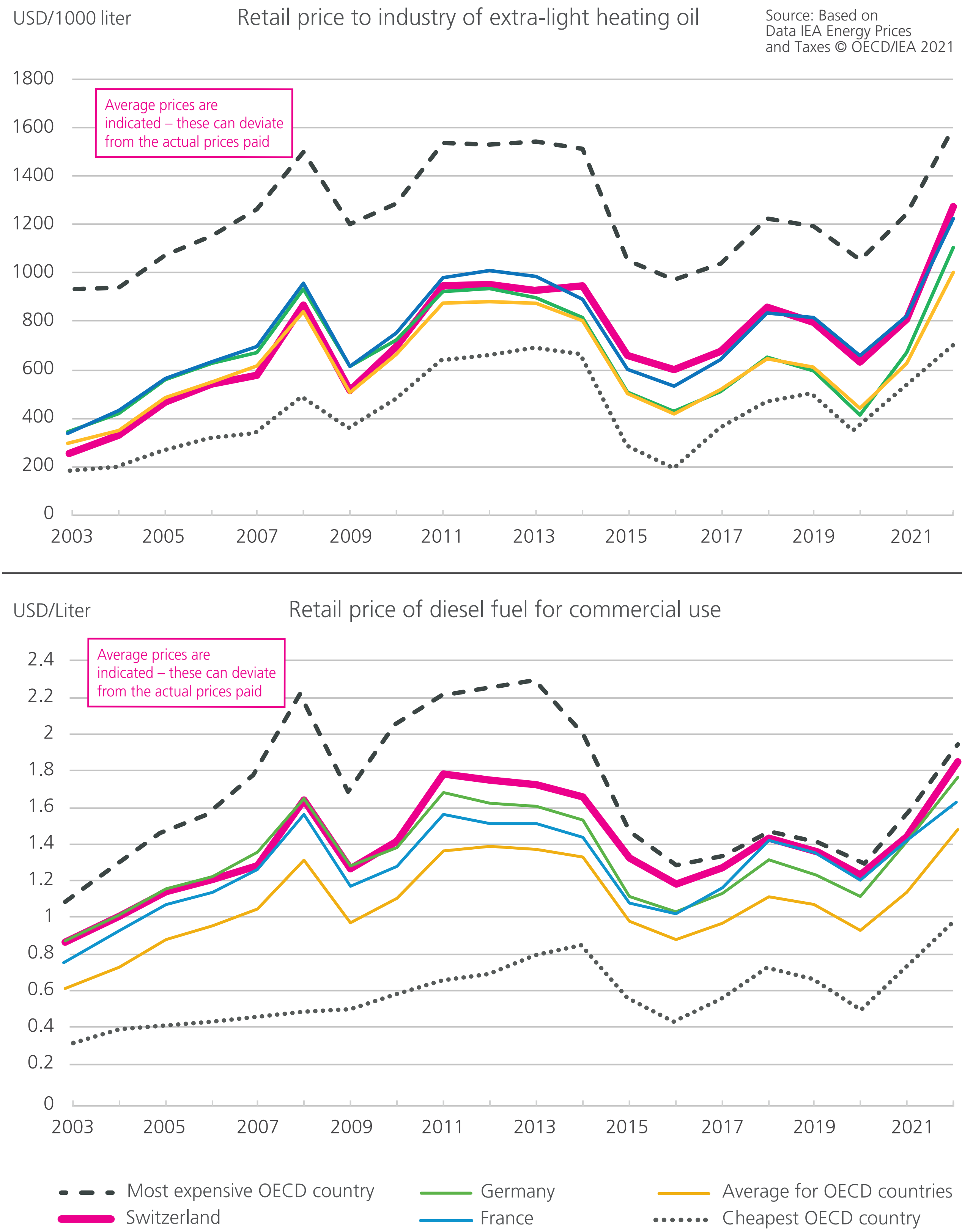
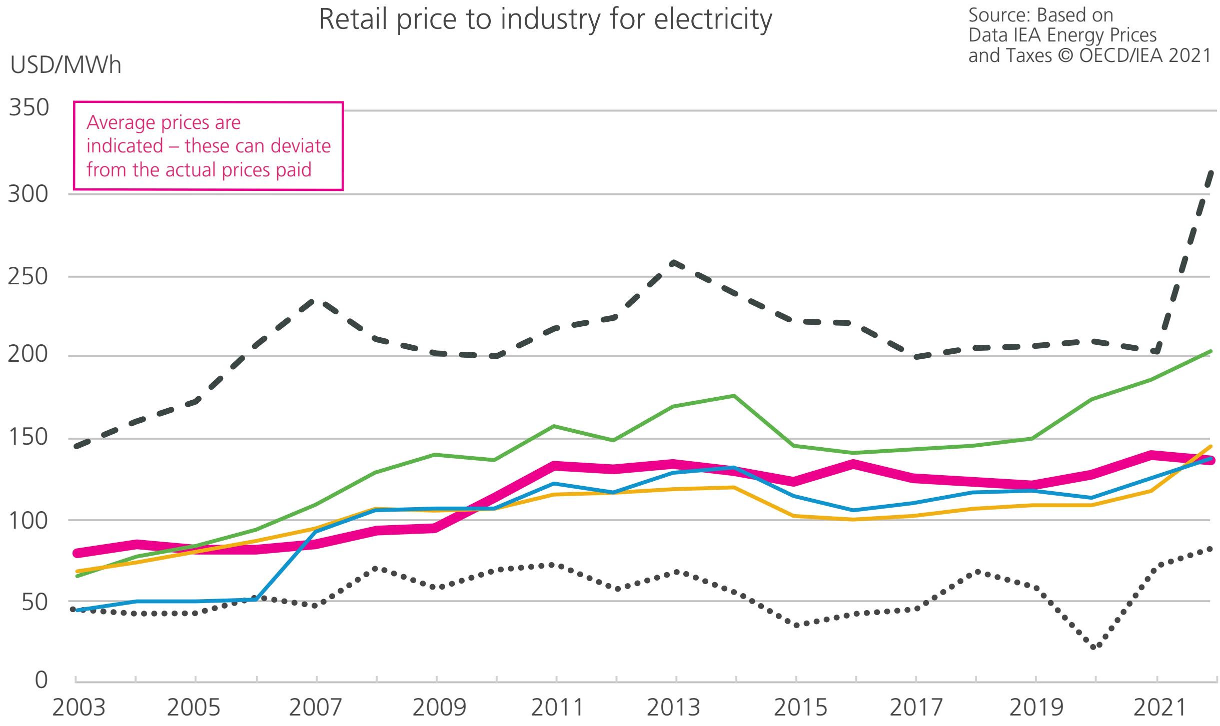


Figure 12: Average nominal end consumer prices for heating oil and diesel including taxes for the industry sector, nominal, in USD (based on market exchange rates)

As a result of Russia's military intervention against Ukraine, there were sharp increases in energy prices worldwide in 2022. In order to control these rises, some national governments directly subsidised businesses and households, or put in place temporary price caps, for example in the form of lower taxation. In France, for example, a tax reduction actually resulted in lower sale prices for motor fuel, as reflected in **Figure 12** with diesel prices. Indirect measures, i.e. payments to individuals and businesses, had no impact on sale prices and are therefore not visible in the aforementioned chart. Switzerland refrained from implementing such price control measures, which should be borne in mind when comparing with other countries for 2022.

Oil as a raw material, and the energy sources 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 graph *(cf. Figure 12*). The price of Swiss **heating oil** rose sharply in 2022 and was still above the OECD average. The price rise in 2022 was similar to that in neighbouring countries. However, when viewed over time, prices in Switzerland have risen slightly more sharply than in other countries. This could be explained – at least in part – by the gradual increase in the CO_2 levy since its introduction in 2008, from CHF 12 to CHF 120 per tonne of CO_2 in 2022. These increases were made because the interim emissions reduction targets from fossil fuels set by the Federal Council every two years were not achieved. The price level for **diesel** in Switzerland was slightly higher than in France and Germany or about average compared to OECD countries – the prices of this oil-based product also increased sharply last year in all observed countries. The price in France has risen since 2018 to a level similar to that in Switzerland. However, due to a temporary tax cut on petrol and diesel, France had much lower prices in 2022 (*see blue curve in Figure 12*). Information about comparative international petrol prices is not monitored in the report because petrol is less significant for industry. The diesel price in Switzerland is much closer to that in the most expensive rather than the cheapest OECD country (source: OECD/IEA, 2023a).

ENERGY PRICES FOR SECTORS IN INDUSTRY IN INTERNATIONAL COMPARISON



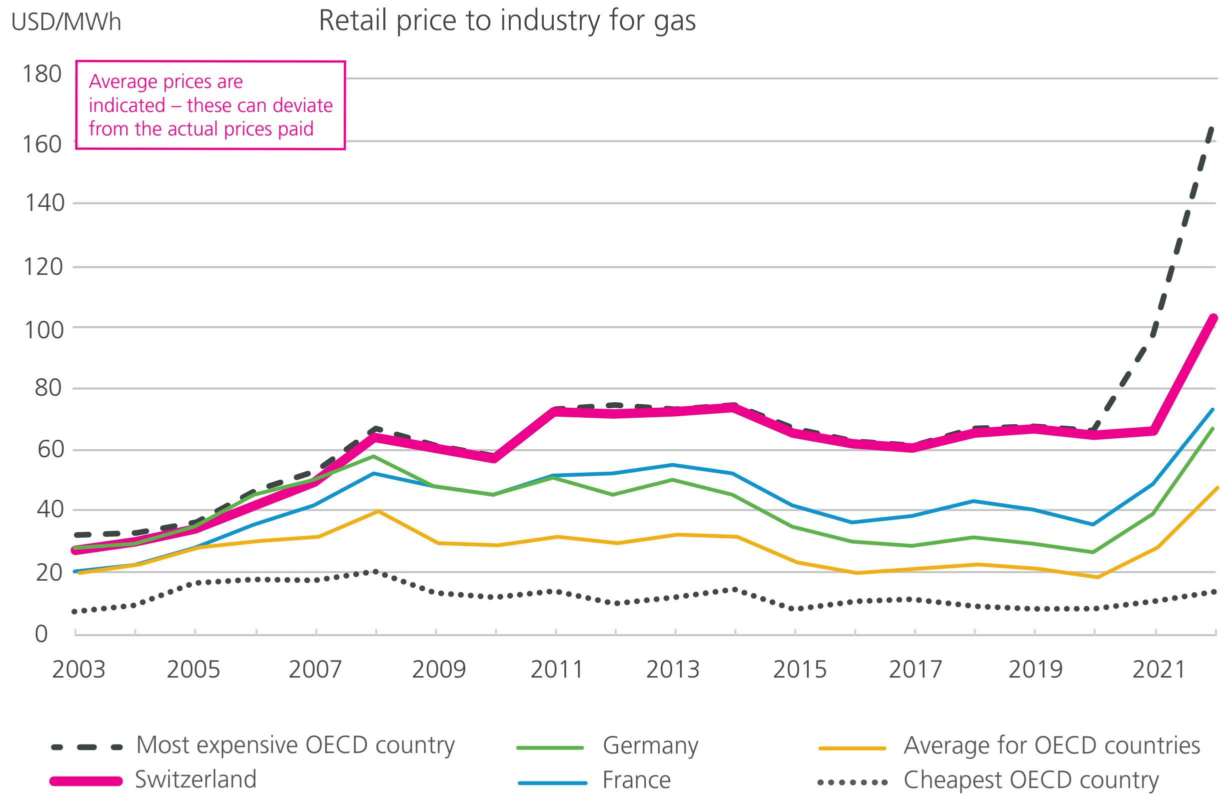


Figure 13: Average nominal end consumer prices of electricity and gas, including taxes for the industry sector, in USD (based on market exchange rates)

The **electricity price** depends on many factors, including the technology used in production, the production and transport costs, capacity of the networks, market structures and levies. Electricity prices in Switzerland remained largely stable compared with the OECD average up until 2020 (*cf. Figure 13*). However, in 2021, and particularly in 2022, there were sharper price rises in a number of countries, for example in Germany. The price level in Switzerland did not change substantially in 2022 and is now slightly below the OECD average, on a par with that of France and well below that of Germany. The differences in level should be interpreted with caution, however. This is partly because electricity-intensive businesses may be exempt from certain levies included in the price. The 2022 prices for basic supply customers were already set in August 2021, which means that the strong increase in electricity prices in 2022 is not reflected in the data for these customers. On top of this, a number of comparable countries subsidised major electricity users in order to cushion the electricity price increase. These direct subsidies are not visible in the chart either. Domestic prices for **gas** are much higher than in Germany and France, and about average for OECD countries. In 2010, 2011 and 2013 up until 2020, Switzerland was the most expensive country in the OECD. In 2021, Sweden replaced Switzerland as the most expensive country in the OECD, which is probably partly due to Sweden's CO_2 levy, which has been continually rising over the years (117 EUR/tonne in 2022). A significant price increase can be seen in all countries in 2022 due to Russia's military intervention against Ukraine. The extent to which state subsidies to cushion the price rises are reflected in the prices, varies from country to country. For example, Germany's gas price cap for industrial companies only came into effect in 2023.

The difference to the other OECD countries is substantial, and in particular in contrast to Canada, the country with the lowest prices in 2022. There are various possible explanations for the price difference: for example, as mentioned above, the CO_2 levy on fossil thermal fuels was increased, which is reflected in the figures. It should also be noted that some companies[14] are able to gain exemption from the levy 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 are able to apply for a refund of the levy. The CO_2 levy is only a partial explanation for the relatively high prices and is no explanation for the figures prior to 2008. Other potential explanations include the higher grid costs (arising because there are only a low number of connections per kilometre), and the intensity of competition. For example, the gas markets in the countries to which Switzerland is being compared were all fully opened up. In Switzerland, gas sales conditions in 2012 were regulated for major industrial customers on the basis of an association agreement, according to which a few hundred end users can choose their gas supplier. In June 2023, the Federal Council defined the parameters for the dispatch on gas supply legislation and proposed a partial opening up of the market, under which customers with consumption of over 300 MWh a year (i.e. major consumers), would get free access to the market. Since June 2020 the gas market in the Lucerne area has been fully opened up following a decision by the Competition Commission. (Sources: OECD/IEA, 2023a/Federal Council, 2019b+2023c/COMCO, 2020).

14 Including companies in certain sectors that have a high tax burden in relation to their value, and whose international competitiveness would be greatly undermined as a result; cf. CO_2 Ordinance, Annex 7 (activities that qualify for exemption from levy with reduction obligations). These companies can apply to have the CO_2 levy refunded. Large CO_2-intensive companies participate in the emissions trading system and are (also) exempt from the CO_2 levy.

↗ For more detailed indicators regarding
EXPENDITURE AND PRICES
see the full monitoring report.

CO_2 EMISSIONS

Energy and climate policy are closely linked, as around three quarters of Switzerland's greenhouse gas emissions are attributable to the use of fossil fuels. Energy Strategy 2050 is intended to contribute to lowering the consumption of fossil energy, and thus the level of energy-related greenhouse gas emissions. It therefore supports achievement of the climate policy targets as set out in the Federal Act on the Reduction of CO_2 Emissions (CO_2 Act) and the Federal Act on Climate Protection Targets, Innovation and Strengthening Energy Security (CIA) (Federal Council, 2019a+2021a / Federal Gazette, 2022). The most significant greenhouse gas in terms of volume is carbon dioxide (CO_2), which is mainly produced when fossil combustibles and fuels are burnt (heating oil, gas, petrol, diesel). The annual monitoring process traces the development of CO_2 emissions per capita, in total and in the individual sectors, as well in relation to other variables. The main 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 UN Framework Convention on Climate Change.

PER CAPITA ENERGY-RELATED CO_2 EMISSIONS

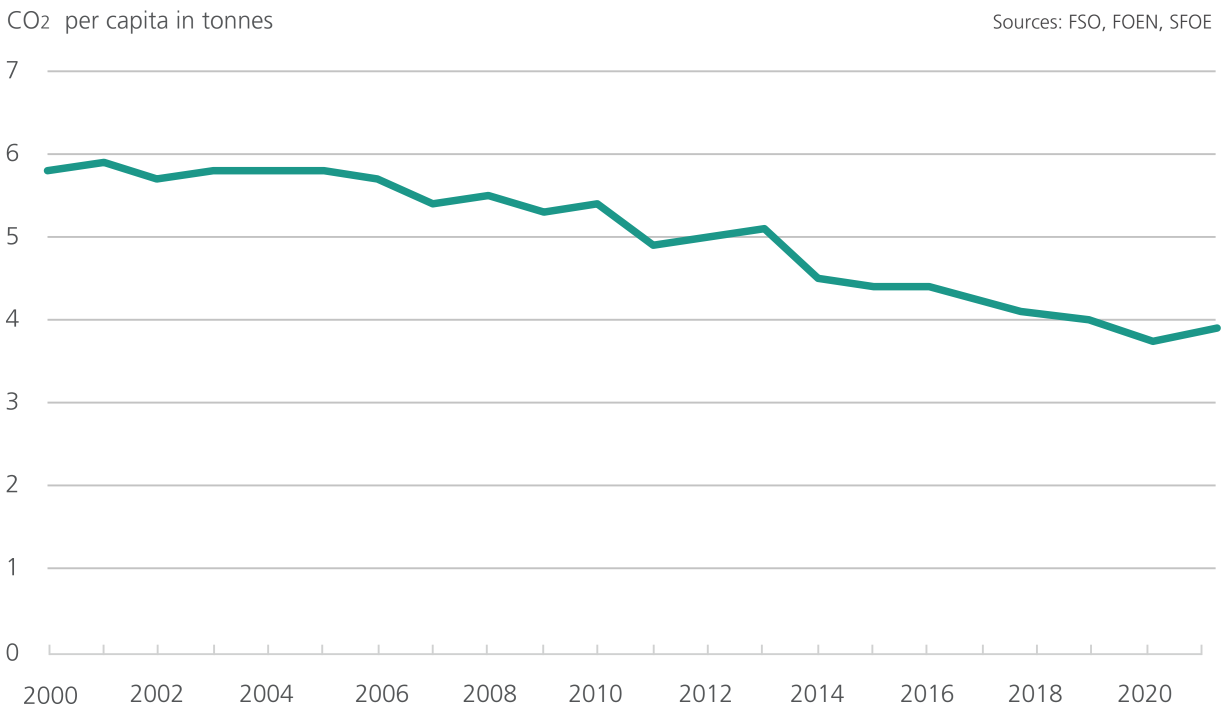


Figure 14: Per capita energy-related CO_2 emissions (in tonnes of CO_2 per capita) [15]

Energy Perspectives 2050+ describes how Switzerland can restructure its energy supply by 2050 in line with the Federal Council's net zero target (Prognos / TEP / Infas / Ecoplan, 2020). Energy-related CO_2 emissions must also pursue this target. This means that the previous long-term strategic goal in accordance with the 2013 Dispatch to Parliament on an initial package of measures for Energy Strategy 2050, which called for energy-related CO_2 emissions to be reduced to 1 to 1.5 tonnes per capita by 2050, has been superseded. In a net-zero world, in which all avoidable emissions have to be eliminated by 2050, in accordance with Energy Perspectives 2050+, around 0.4 tonnes of energy-related CO_2 are still emitted per capita.

Energy-related CO_2 emissions per capita have been continually falling In Switzerland since 2000, as shown by **Figure 14**. While CO_2 emissions from energy sources have fallen slightly since 2000, the population of the country has constantly increased during the same period. There thus appears to be an increasing separation of the factors of population growth and CO_2 emissions. In 2021, domestic per capita emissions amounted to around 3.9 tonnes and were thus almost 33% lower than the level recorded in 2000 (5.8 tonnes).[16] When compared internationally, this is a relatively low figure resulting from the fact that Switzerland's electricity production is largely CO_2-free and the services sector contributes a major share of the added value. However, in order to achieve the climate target of net zero greenhouse gas emissions by 2050, the energy-related CO_2 emissions per capita will have to be reduced to a greater extent than in the past (sources: FOEN, 2023 / FSO, 2023a / SFOE, 2023a).

15 Differentiation according to the CO_2 Act (excluding international aviation, including statistical difference). Not weather-adjusted.

16 To provide a comparison: Per capita emissions of all greenhouse gases amounted to around 5.2 tonnes in 2021. This is equivalent to a reduction by almost 31% versus the figure for 2000 (7.5 tonnes). Thus in percentage terms, per capita energy-related CO_2 emissions have fallen to a slightly higher extent than overall greenhouse gas emissions.

ENERGY-RELATED CO_2 EMISSIONS OVERALL AND BY SECTOR

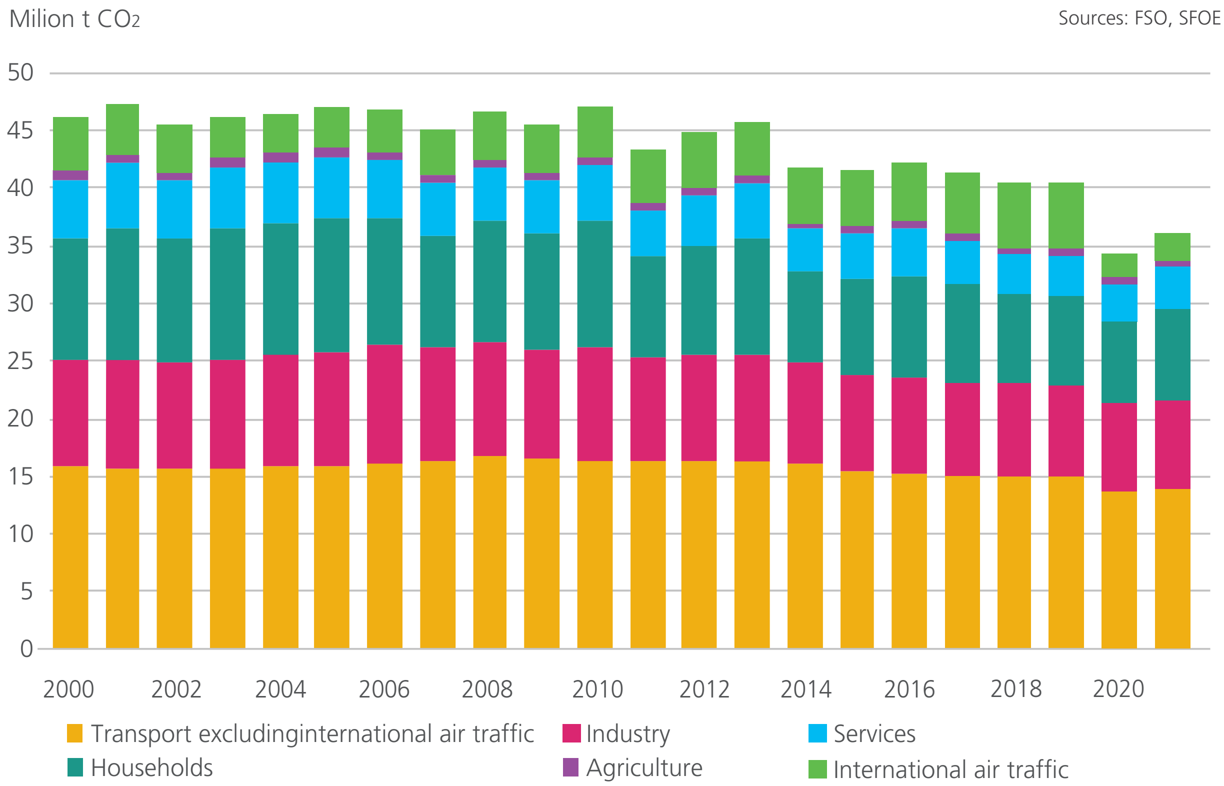


Figure 15: Total energy-related CO_2 emissions and by sector (in million tonnes of CO_2)

Overall CO_2 emissions from energy sources (*cf. Figure 15, including international air traffic)* amounted to 36 million tonnes of CO_2 in 2021, and were therefore 22% lower than in 2000. The transport sector accounts for the highest proportion (2021: 38%; excluding international air traffic), in which motorised road vehicles are responsible for a large share of the emissions.[17] Between 2000 and 2021, CO_2 emissions in the transport sector fell by around 2 million tonnes. After a decrease at the beginning of the millennium, emissions from international air traffic have been constantly increasing since 2005 and reached 5.7 million tonnes of CO_2 in 2019. Owing to the COVID-19 pandemic, however, these emissions declined sharply in 2020, and were still well below previous levels in 2021, at 2.3 tonnes of CO_2 (proportion of 6%)[18]. In the industry sector (proportion in 2021: 23%), energy-related CO_2 emissions primarily result from the production of goods, and to a lesser extent from the heating of buildings. A slight decline has been reported since 2000, illustrating the effectiveness of the implemented measures, as well as increases in energy efficiency and a decoupling of CO_2 output and industrial production. The fluctuations over the course of time are primarily attributable to the state of the economy and climatic conditions. In the **households sector** (proportion in 2021: 22%), the emissions are largely attributable to heating and hot water production. Since 2000, the emissions have fallen, although the volume of space to be heated has increased. This also shows there has been an increase in efficiency and a tendency to use technology creating lower CO_2 emissions. Because there are still numerous fossil-based heating systems in use, the annual emissions depend to a large extent

ENERGY-RELATED CO_2 EMISSIONS OVERALL AND BY SECTOR

on the weather conditions. Emissions are higher in years with relatively cold winters, and lower in years with warmer winters. The same applies to the **services sector** (proportion in 2021: 10%). Here, too, CO_2 emissions from energy sources have been declining slightly since 2000, but the levels fluctuate according to the weather conditions. In the agriculture sector, CO_2 emissions from energy sources have similarly decreased slightly since 2000, while the overall share in CO_2 emissions is very low (2021: 2%). In the **agriculture sector**, it is not energy-related CO_2 emissions that are of significance, but rather above all methane and nitrogen dioxide. Overall, each sector's share of energy-related CO_2 emissions has only changed to a minor extent since 2000. Emissions from the transport and industry sectors have increased (from 34 to 38% and 20 to 22% respectively), while the households and services sectors contributed slightly less (sources: FOEN, 2023+2022a / SFOE, 2023a / Ecoplan, 2017 / Ecoplan / EPFL / FHNW, 2015).

17 In certain publications, the SFOE shows the proportion of transport to total greenhouse gas emissions, which is currently around one third (32%).

18 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 proportion to overall CO_2 emissions would be around 14%. If this segment is allocated to the overall transport sector, the share would be 27%.

For more detailed indicators regarding
CO_2-EMISSIONS
see the full monitoring report.

RESEARCH AND TECHNOLOGY

To achieve the long-term objectives, new developments in the technology sector will be required. To stimulate further development, Switzerland has allocated significantly more resources to energy research. Progress in research and technology cannot generally be measured directly with indicators. For this reason the annual monitoring process focuses on public expenditure for energy research as an indicator for efforts being made in this regard.

PUBLIC EXPENDITURE FOR ENERGY RESEARCH

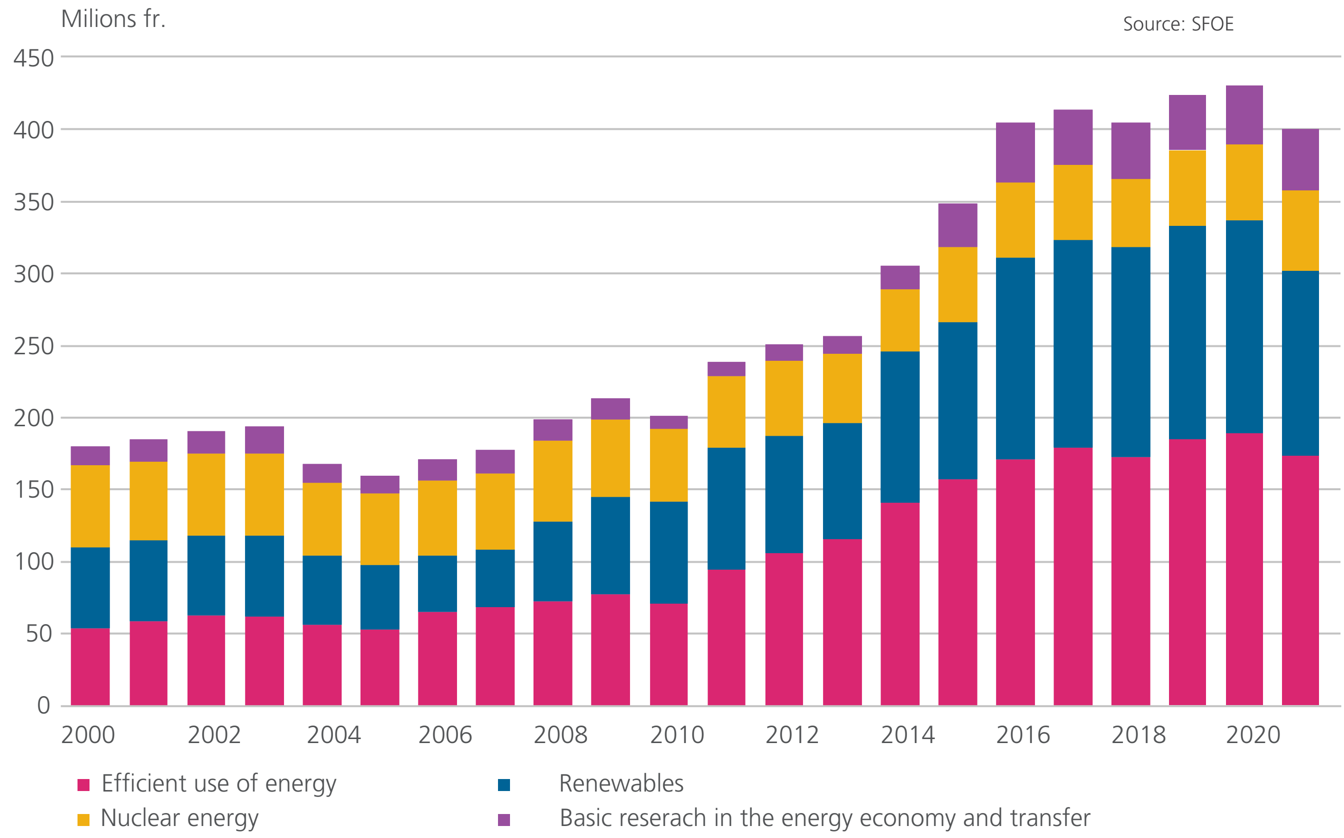


Figure 16: Public expenditure for energy research by field of research (in CHF million [real figures])[19]

Public funding for energy research increased continuously between 2005 and 2020, as shown in **Figure 16.** Above all, a significant increase in expenditure has been noted since 2014 within the framework of Energy Strategy 2050 and the Coordinated Energy Research in Switzerland action plan. A major contribution has been made through the development and creation of the Swiss Competence Centres for Energy Research (SCCERs) by Innosuisse, the new National Research Programmes in the energy sector (NRP 70 and NRP 71) by the Swiss National Science Foundation (SNSF), and the targeted expansion of pilot, demonstration and flagship projects by the SFOE. In 2021, public expenditure in the sector amounted to CHF 400 million in real terms (2020: close to CHF 432 million). The decline compared with previous years can be attributed to the expiry of the SCCER energy funding programme, leading to the ETH Doman and Innosuisse contributing less to energy research in Switzerland. The successor programme to SCCER, known as the SWEET funding programme, has less funding and will probably not fully compensate for the decline in future.

In accordance with the priorities of Energy Strategy 2050, the largest amounts of funding flow into the fields of energy efficiency (share in 2021: 43.7%) and 2019: 43.6%) and renewable energy (share in 2021: 31.8%). Absolute expenditure for nuclear energy research (nuclear fusion and nuclear fission) has been stable since 2004, but its proportion to total expenditure has fallen and amounted to 14.2% in 2021. The share of expenditure for basic energy research was 9.1% (source: SFOE, 2022a+2023d).

19 Expenditure includes a share in overheads (indirect research costs) of the research institutions.

↗ For more detailed indicators regarding
RESEARCH AND TECHNOLOGY
see the full monitoring report.

INTERNATIONAL ENVIRONMENT

The international environment is important for Switzerland because the country is closely integrated into the international energy markets and is dependent on energy imports. Developments in Europe at the regulatory level are of central importance for Switzerland. International efforts to combat climate change also play a major role. The annual monitoring process focuses on a descriptive overview of substantial developments.

DEVELOPMENT OF GLOBAL ENERGY MARKETS

Europe and other parts of the world currently face fluctuating energy prices, which are indicative of uncertainty in the energy markets. The economic recovery after the COVID-19 pandemic and the associated increase in demand for energy already caused energy prices to rise sharply in 2021. Russia's military intervention against Ukraine has exacerbated the energy crisis and in particular further driven up gas and electricity prices, which reached a peak in early 2023. In an attempt to reduce dependence on Russian gas, the EU put in place various measures to diversify its gas supply and set a 15% demand reduction target for autumn/winter 2022/2023 compared with previous years. In addition, the European CO_2 price increased sharply, reaching an all-time high in the first quarter of 2023.

Oil: In its medium-term forecast, the International Energy Agency (IEA) anticipates that global demand for oil will reach around 105.7 million barrels per day in 2028. That equates to an increase of 5.9 million barrels a day compared with 2022. According to the IEA, this growth is particularly driven by aviation and the petrochemical industry. On the supply side, by 2028 the IEA forecasts growth in production capacities by 5.9 million barrels per day to 111 million versus 2022.

In 2022, demand was at 99.8 million barrels a day, which is 2.3 million barrels a day more than in 2021. For 2023, the IEA anticipates that demand will climb further to 102.3 million barrels a day, taking it to a record level. As the post-pandemic upswing loses momentum, and the weak economy, stricter efficiency standards and new electric vehicles impact consumption, a decline in growth of 1 million barrels a day is projected for 2024.

According to the forecasts, global oil output will increase by 1.5 million barrels a day in 2023, reaching a record high of 101.5 million barrels a day, with the United States being the main driver behind this increase.

Just after the beginning of Russia's military intervention against Ukraine in March 2022, oil prices reached a historic high, at USD 130 a barrel. Over the course of 2022, the price fluctuated sharply, falling to just over USD 85 per barrel by the end of December. The first half of 2023 was marked by price volatility: in mid–March, the oil price fell below USD 75 a barrel for the first time since 2021, and then climbed back up to USD 87 a barrel four weeks later. Following a brief period of calm on the oil markets, prices rose again in the summer. In August 2023, the price was at USD 85 a barrel, while in September it climbed back above the USD 95 a barrel mark for the first time since the end of 2022. This came after Saudi Arabia and Russia had extended their voluntary oil supply cuts until the end of 2023. In early October, the price fell again slightly, to USD 85 a barrel. The escalation of violence in Israel has caused the oil price to rise again, to over USD 90 a barrel in mid-October (source: OECD/IEA, 2023b).

Gaz: In its medium-term forecast, the IEA anticipates annual growth in global gas demand of 1.7% up to 2024 – slightly lower than the 1.8% growth prior to the pandemic – which means that global demand will reach around 4,300 billion cubic metres in 2024. Global gas production in 2024 is expected to be around 6% higher than before the pandemic in 2019 and amount to 4,328 billion cubic metres.

After a very turbulent year in 2022, the global gas markets calmed down slightly in early 2023. Spot gas prices across the key northeast Asian, North American and European markets dropped by close to 70% between mid-December and the end of the first quarter of 2023, while storage sites ended the heating season

DEVELOPMENT OF GLOBAL ENERGY MARKETS

well above their five-year averages. The IEA expects global gas supply to remain tight in 2023.

Following extremely high prices in the first quarter of 2021 (USD 23.86 per million British Thermal Units (MMbtu)), the price levelled out at under USD 10 on the US market (Henry Hub). The Henry Hub Natural Gas Spot Price is currently just over USD 2, compared with USD 6 or 7 in the summer of 2022. This equates to a year-on-year decrease of 71.5%. The Henry Hub price is expected to increase to around USD 4 by early 2024. In Europe, the TTF spot price temporarily fell to 30 EUR/MWh at the end of October 2022. A series of LNG cargos could not be unloaded at the hubs in northwest Europe because the storage facilities were full and the gas network in the region was overloaded. The spot price quickly recovered, however, reaching a high of around 150 EUR/MWh in early December 2022, before falling again sharply to around 70 EUR/MWh. It then continued its downward trend until mid-March 2023. After that, the spot price levelled off at between 30 and 45 EUR/MWh. Natural gas prices rose again in early October. This price rise was driven in part by the closure of a large natural gas field in Israel due to the escalating violence, and the closure of a gas pipeline between Finland and Estonia due to damage. The TTF spot price was at just under 50 EUR/MWh in mid-October (sources: EU 2022/OECD/IEA 2023c/U.S. Energy Information Administration[20]).

Coal: Global coal consumption increased strongly in 2021 by 6% to 7,929 million tonnes (Mt), after experiencing a sharp decline the previous year due to the outbreak of the COVID-19 pandemic. A robust economic recovery, particularly in countries that are heavily dependent on coal, such as China and India, and the higher natural gas prices, led to a wave of switching to coal as a fuel, with a rise in coal for power generation of 8% to 5,344 million tonnes. The stronger industrial activity led to an increase in coal consumption for purposes other than power generation, of 2.2% to 2,585 million tonnes.

Global coal production increased by 5.4% to 8,318 million tonnes in 2022, which is a new record and well above the previous record set in 2019. This follows an increase of 3.9% to 7,888 million tonnes in 2021, as economies were recovering from the fall in demand caused by the pandemic in 2020. In absolute terms, the growth in 2021 was mainly driven by production increases of 153 million tonnes in China (4%) and 48 million tonnes in India (approx. 6%). Growth in global coal production is expected to reach a peak in 2023 that is only slightly above the 2022 level.

Coal production is then expected to fall to 8,221 million tonnes by 2025, therefore dipping back below the 2022 level. The lower levels largely reflect expectations that Chinese coal production is set to plateau in the coming years, and that the sustained growth in Indian coal production (+128 million tonnes) will be offset by sharp declines in other regions, such as the United States (–92 million tonnes), the European Union (–68 million tonnes), Indonesia (–40 million tonnes) and Russia (–13 million tonnes).

The international coal trade slowly recovered from the economic effects of the COVID-19 pandemic in 2021, with volumes rising to 1,333 million tonnes, which equates to around 17% of global coal demand.

In addition to gas prices, coal prices also increased strongly until August 2022. At the beginning of the year the Indonesian government issued a general ban on coal exports for the whole of January, thereby shoring up coal prices. The growing tensions in the Ukraine conflict also impacted on coal prices, causing them to surge in response to uncertainty about future coal deliveries from Russia in light of EU sanctions. In April 2022, the EU and Japan announced their intention to

DEVELOPMENT OF GLOBAL ENERGY MARKETS

ban imports of coal from Russia. The ban on Russian coal imports went into effect in the EU from 10 August 2022, fuelling uncertainty about a potential shortage of non-Russian coal.

The desire to reduce Europe's dependence on Russian gas imports also raised the expectation that coal combustion would be higher in 2022 and 2023 than previously, which in turn drove up demand for coal. In May 2022, worsening supply shortages in South Africa, where rail transhipment had deteriorated, gave rise to bullish sentiment. During the summer, low water levels in the Rhine restricted coal shipments along the river from the ARA ports[21] to end consumers, leading to concerns about autumn availability and increasing prices. Over the course of the year, the coal price rose from just under EUR 80/t to just short of EUR 173/t with temporary highs of over EUR 345/t. (Sources: OECD/IEA 2022a+b/ElCom 2023b)

CO_2 in European emission trading: Russia's military intervention against Ukraine caused the CO_2 price to fall sharply (from EUR 96/t to EUR 60/t of CO_2), thereby following the trend on the global financial markets. The CO_2 price peaked in summer 2022, at EUR 101/t of CO_2). The lower wind power production was offset by higher production from fossil combustible fuels, which boosted demand for CO_2 certification and drove up prices. In the summer of 2023, the price oscillated between EUR 80 and 90 Euros per tonne of CO_2. The front year base-load contracts up to 2026 range between EUR 90 and 100 per tonne of CO_2. Following the significant fluctuations in the second half of 2022, the market seems to have calmed down.

Electricity: The IEA expects global electricity demand to grow by just under 2% in 2023, down from a rate of 2.3% in 2022 and demand of 26,991 TWh. This decrease is mainly due to declining electricity demand in advanced economies that are grappling with the ongoing effects of the global energy crisis and an economic slowdown. On the other hand, the IEA expects significant growth in electricity demand in China (+5.3%) and India (+6.5%) compared with 2022.

According to the IEA, the accelerated expansion of renewables worldwide shows that, depending on weather conditions, 2024 could become the first year in which more electricity is generated from renewables worldwide than from coal. It estimates that 8,546 TWh of electricity was generated from renewables in 2022. This prediction is based on the expectation that electricity generated from coal will decline slightly in 2023 and 2024, after increasing by 1.5% in 2022 when high gas prices boosted demand for alternatives. The decline in coal-fired generation is likely to be very marked in the United States and Europe, but it will probably be almost offset by an increase in Asia. The availability of hydropower requires greater attention, according to the IEA. Recent years have seen intense droughts that have caused a significant reduction in hydropower availability in affected regions such as Europe, Brazil and China. Anticipating challenges on hydropower related to climate change, and planning accordingly, will be crucial for the efficient and sustainable use of hydro resources.

Fossil fuels are the largest sources of energy for electricity generation in the United States, with natural gas making up the largest source at 40%, followed by renewable energies at 22%, and nuclear energy and coal, each making up around 18%. In 1990, renewable energies only accounted for around 12% of electricity generation. Since 2008, natural gas has gradually replaced coal and the share of natural gas is now double that of coal. In 2008, it was the other way round.

Electricity demand in the European Union is set to fall in 2023 for the second year in a row, reaching its lowest level in two decades. This is despite record sales of electrical vehicles and heating pumps. The European Commission estimates that almost two thirds of the net decline in the EU's electricity demand in 2022 was due to energy-intensive industries that were grappling with very high energy prices. This trend continued well into 2023, although prices for energy resources and electricity fell. In 2022 the share of renewables in the EU's energy mix rose to 39% with total production

DEVELOPMENT OF GLOBAL ENERGY MARKETS

of 2,701 TWh (-3% versus 2021). In 2022 a new record was set in the EU in terms of installed renewable capacity (+57 GW solar and wind capacity). Fossil fuel production increased by 3% in 2022 (+24 TWh), supported by a drop in electricity generation from nuclear and hydropower. Overall, coal-fired generation increased by 6% (+24 TWh), while gas-fired generation only rose slightly, by less than 1% (+1 TWh).

Electricity wholesale prices on European markets reached record levels several times in 2022, with a historical peak reached in August. The loss of natural gas supplies via the Nord Stream 1 and 2 pipelines, the reduced availability of nuclear power plants, particularly in France, and decreased hydropower production due to a lack of snowfall and precipitation, led to record high gas prices, which further increased pressure on the already tight market. In 2022 the European Power Benchmark[22] was at 230 EUR/MWh on average, 121% higher than in 2021. Italy had the highest electricity baseload prices in 2022 (at 304 EUR/MWh on average), followed by Malta (294 EUR/MWh), Greece (279 EUR/MWh) and France (275 EUR/MWh) (sources: OECD/IEA, 2023d/EU, 2022a+b/Eurostat 2023).

20 Cf.: U.S. Energy Information Administration - EIA - Independent Statistics and Analysis

21 Amsterdam, Rotterdam, Antwerp

22 IIndex of average wholesale electricity prices on the European market

DEVELOPMENTS IN THE EU

The European Green Deal is a top priority in the current legislative period until 2024 under the EU Commission President, Ursula von der Leyen. Through the Green Deal, the EU wants to become the world's first climate-neutral continent and transition to a modern and resource-efficient economy. On 14 July 2021, the European Commission proposed a comprehensive legislative package entitled **Fit for 55** which sought to reduce net greenhouse gas emissions by 55% compared with 1990 levels by 2030. With the exception of the revision of the EU Energy Taxation Directive, which is blocked in the EU Council due to the unanimity requirement, the colegislators, the EU Council and the European Parliament, agreed on all the legislative proposals in 2023 and have in large part already formally adopted them. The package covers the following areas: (Source: COM(2021) 550 final/COM (2022) 230 final):

- Revision of the EU emission trading system (EU-ETS)
- New ETS in road transport and buildings sector
- CO_2 emission reduction in non-ETS sectors
- Introduction of a Carbon Border Adjustment Mechanism (CBAM)
- Tightening of emissions standards for vehicles
- Revision of the Regulation on land use, land use change and forestry (LULUCF)
- Revision of the Energy Taxation Directive
- Revision of the Renewable Energy Directive
- Revision of the Energy Efficiency Directive
- Alternative Fuels Infrastructure Regulation
- Regulation on Sustainable Maritime Fuels
- Regulation on Sustainable Aviation Fuels

In connection with the Fit for 55 package, the EU Commission put forward a legislative proposal in December 2021 to revise the Energy Performance of Buildings Directive. As part of RePowerEU, the EU's plan to end reliance on Russian fossil fuels, the Commission proposed other amendments. The Directive is currently being validated by the colegislators in the so-called trilogue. It includes solar energy commitments, an EU-wide harmonised building energy performance certificate, substantial renovation obligations for inefficient buildings, and more stringent requirements for building charging stations in buildings.

Amid the economic upheaval of the COVID-19 pandemic, the EU established an economic recovery and resilience facility **in the form of the Next Generation EU programme**. Through the first-of-its-kind common borrowing by the EU, member states can access EUR 340 billion in direct payments and EUR 390 billion in low-interest loans with which they can finance national recovery and resilience plans. Member states have to allocate 37% of their budgets to green measures. Member states are currently implementing their plans. The majority of the green measures go to sustainable mobility (33%), energy efficiency (28%) and renewable energies and networks (12%) (source: COM(2020) 456 final).

In response to the massive upheaval in the EU domestic market on account of the energy crisis, the EU Commission put forward a set of legislative proposals in March 2023 designed to **revise the rules for electricity market design** and to overhaul the rules for **market integrity and transparency of the wholesale electricity market (REMIT)**. Revising the rules for electricity market design will not mean any fundamental changes to the way the markets operate.

DEVELOPMENTS IN THE EU

Nor are there any plans to reverse the integration and liberalisation of the internal EU electricity market that have taken place in the last 20 years. Instead, the revision seeks to strengthen short- and long-term markets, reduce market dependence on fossil gas, and to protect end consumers from price spikes. The revision of REMIT concerns the extension of data reporting obligations to other markets, such as balancing energy markets, strengthening the European Union Agency for the cooperation of Energy Regulators ACER, and enhancing cooperation between ACER and the European Securities and Markets Authority ESMA. The revisions are currently being debated by the colegislators, the EU Council and European Parliament. The revisions are expected to be adopted in Q1 2024 (source: European Commission 2023).

INTERNATIONAL CLIMATE POLICY

With respect to the further implementation of the **Paris Climate Change Agreement**, the signatory states met in November 2022 for the 27th UN Climate Change Conference in Sharm el-Sheikh (COP27). The goal of the conference was to adopt a concrete work programme for climate protection, which is what countries committed to at the previous COP26 in Glasgow. At COP27, countries agreed on such a work programme for the period up until 2026. However, this does not place any specific obligations on major emitters. Switzerland regrets this decision. It will work to ensure that these countries also play their part so that the 1.5 °C target can still be achieved. Meanwhile, no decisions were made on phasing out coal or abolishing oil and gas subsidies. The largest emitters in particular – such as China, India, Indonesia and Brazil – rejected this work programme and refused to commit to implementation plans. Concrete actions to align global financial flows with the 1.5° C target were rejected by a group of developing countries. The world's poorest countries and island nations are particularly hard hit by climate change. At COP27 the states decided to create a new fund designed to support the most vulnerable countries in dealing with the loss and damage caused by climate change (e.g. flooding and drought). At the COP, Switzerland campaigned to ensure that the fund would benefit the most vulnerable developing countries. It welcomes the additional support in principle but regrets that key questions remain unanswered. For example, it is not clear which countries should make up the donor base, how the funds will be distributed and who will manage it. Switzerland will work to clarify these questions as quickly as possible. Important progress was made in implementation of the Santiago Network. This network of UN agencies and NGOs can now connect countries particularly affected by climate disasters with providers of technical assistance, such as the development of early warning systems.

After years of negotiation on the part of the international community, the Paris Agreement was adopted in December 2015 and entered into force on 4 November 2016. It followed up on the second commitment period of the Kyoto Protocol and obliges all countries to adopt measures to reduce greenhouse gas emissions, with the common objective of limiting the increase in the global average temperature to well below 2 °C above the pre-industrial level, while at the same time striving to limit the temperature increase to 1.5° C. The further aims of the Agreement include 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. All 197 parties to the United Nations Framework Convention on Climate Change (UNFCCC) have adopted the Convention and 195 countries, as well as the EU, have ratified it. The United States' withdrawal from the Paris Agreement, instigated by former US President Trump, was reversed by his successor Joe Biden shortly after he took office. The United States rejoined the Paris Agreement in February 2021.

Switzerland signed the Paris Agreement in 2015 and ratified it in autumn 2017. Switzerland's target calls for a halving of the total greenhouse gas emissions by 2030 versus the 1990 level. For the implementation of the Agreement by 2030, the Federal Council and Parliament resolved to revise the existing CO_2 Act. After the Swiss electorate rejected the first bill in June 2021, the Federal Council approved the dispatch on the revised CO_2 Act in September 2022. This bill takes account of the reservations about the rejected revision and refrains from introducing new or higher taxes. Instead, it focuses on targeted funding to channel investment into climate-friendly solutions. Following the ratification of the Paris Agreement, Switzerland is also

INTERNATIONAL CLIMATE POLICY

legally obliged to implement measures to combat climate change. As before, it is required to submit a Biennial Report to the Secretariat of the UN Framework Convention on Climate Change concerning the development of greenhouse gas emissions, planned measures to reduce emissions and adapt to climate change, and the contributions made towards the financing of international climate policy.

At the end of March 2023, **the Intergovernmental Panel on Climate Change (IPCC)** published the synthesis report of its 6th assessment cycle. The synthesis report comprises a summary of the state of knowledge on the science of climate change, its widespread impacts and risks, and climate change mitigation and adaptation. It will form the basis of the next climate conference in Dubai in December 2023 (COP 28), where member states will review the progress made in tackling climate change in the first-ever 'Global Stocktake' as provided for in the Paris Agreement. Switzerland is working to ensure that the process results in recommended actions to achieve the targets under the Paris Agreement. These recommendations should apply to all countries, and in particular include the major emitters. Also on the agenda is the work programme to reduce countries' greenhouse gas emissions. In this regard, a resolution is expected at COP28 on the worldwide expansion of renewable energies and energy efficiency. The Swiss delegation is also pushing for resolutions on the phase-out of coal, oil and gas by 2050. Finally, Switzerland will work to ensure that the loss and damage fund benefits the poorest countries and those hardest hit by climate change. The fund should be financed using the polluter-pays principle and should complement the existing disaster and humanitarian aid instruments. (Sources: Federal Council, 2023d+2022c+2021a+c+f+2019b/DETEC, 2021/FOEN, 2022b/IPCC, 2021+2023).

SWITZERLAND'S INTERNATIONAL COOPERATION IN THE ENERGY SECTOR

Switzerland initiated negotiations with the EU on a **bilateral electricity agreement** in 2007. These negotiations came to a halt in the middle of 2018 because the EU insisted that their continuation must be tied to the institutional agreement between Switzerland and the EU. On 26 May 2021, the Federal Council decided to terminate the negotiations on the draft institutional agreement. In February 2022 the Federal Council set out its approach for negotiations with the EU. According to this approach, the federal government will seek to address the pending issues with the EU based on a broad package of measures. Through the negotiating package Switzerland wants to secure access to the EU market and mutual cooperation. It covers areas from the previous Agreement – free movement of people, transport, aviation, agriculture and technical barriers to trade MRA – and three new agreements in the areas of electricity, food safety and health. Following a number of exploratory talks between Switzerland and the EU, the Federal Council adopted the parameters for a negotiating mandate with the EU on 21 June 2023. These parameters specify the areas that the mandate should cover, its general and specific objectives, and the scope for safeguarding Switzerland's interests. The Federal Council is preparing to adopt the negotiating mandate by the end of 2023.

With respect to regional cooperation, Switzerland has participated as a permanent and active observer of the Pentalateral Energy Forum since February 2011. This forum sees the energy ministers from the following countries engage in voluntary cooperation: Germany, France, Belgium, the Netherlands, Luxembourg, Austria and Switzerland. The Forum deals with the issues of electricity market integration, grid operation, security of electricity supply and the future of the energy system. At the end of March 2023, the Pentalateral countries signed a joint declaration to step up cooperation in natural gas storage. Back in early December 2021, the countries had already signed a Memorandum of Understanding on risk preparedness in the electricity sector. This paved the way for further collaboration between the Pentalateral countries on risk preparedness in the electricity sector and provides, among other things, for the countries to conduct regular joint exercises on coping with electricity crises. The most recent such exercise took place in the Hague in October 2023. Representatives of the FONES, ElCom and the SFOE took part from Switzerland. In the winter of 2022/2023, within the framework of the Penta Forum, a number of ad hoc meetings took place at various levels to discuss and implement measures to deal with the energy crisis.

The numerous interdependencies with neighbouring countries in the energy sector call for an intensification of **bilateral relations** in the areas of energy and climate. In light of Russia's military intervention against Ukraine and the tense electricity and gas supply situation, as well as the upheaval on the energy markets, security of energy supply is always on the agenda at bilateral meetings. In the spring of 2022, the then head of DETEC, Simonetta Sommaruga, met with her counterparts from the Netherlands and Italy. In May, she met with the German vice-chancellor Robert Habeck at the WEF. The talks revolved around mutual solidarity in the event of an energy shortage. In early 2023, the new head of DETEC, Albert Rösti, and the minister for economic affairs, Guy Parmelin, also met with the German vice-chancellor at the World Economic Forum in Davos, where they discussed issues around security of supply. They agreed on a number of points, including the fact that no bilateral agreement is needed between Switzerland and Germany for the gas sector. Instead, they agreed that a trilateral solidarity agreement should be negotiated between Italy, Germany and Switzerland. To this end, Federal Councillor Albert Rösti travelled to Italy to meet his counterpart Gilberto Pichetto Fratin in July. For geographical and logistical reasons (integrated grid), the two countries work together closely in gas and electricity supply. The two energy ministers signed an agreement on security of gas supply, which would allow Switzerland to secure gas from Germany in the event of interrupted supply.

In the field of **multilateral cooperation**, Switzerland is active within the multilateral energy institutions, including the International Energy Agency (IEA). In late 2022 and early 2023, Switzerland underwent an in-depth peer review by a team of IEA experts. The final report on the in-depth review was presented to the public in Bern in September in the presence of Federal Councillor Albert Rösti. The IEA recommends that Switzerland press ahead more quickly with converting its energy system and accelerate licensing procedures for energy infrastructure. It also suggests that energy efficiency measures be consistently taken into account in all relevant Swiss policies. Furthermore, it recommends integration in the European electricity market by means of an electricity agreement to boost security of electricity supply. The Federal Council decided in November 2022 to approve the modernised Energy Charter Treaty[23]. In several rounds of negotiations, Switzerland had called for the Treaty to be adapted to current decarbonisation requirements and the new practices in investment protection treaties. In the absence of a position from the EU, the Energy Charter Conference – the highest governing body of the Energy Charter Treaty – has yet to approve the modernised Treaty. Various EU member states claim that even the revised Energy Charter Treaty runs counter to their climate targets, in particularly the envisaged protection of investments in fossil fuels. After Italy withdrew from the Treaty back in 2016, since the autumn of 2022 Germany, France, Poland, Luxembourg, the Netherlands, Spain, Slovenia, Denmark, Portugal and Ireland have announced their intention to withdraw from the Treaty. However, the EU and EURATOM remain parties to the Treaty, as long as the EU Council does not decide to withdraw. In October 2022, Switzerland organised the International Conference on Hydropower in Developing Countries together with the International Renewable Energy Agency (IRENA). Switzerland also had a seat on the IRENA Council until the end of 2022. In addition, Switzerland and Costa Rica head up a group of states within IRENA to develop more hydropower worldwide. Switzerland also engages with the UN in Geneva, particularly with the Committee on Sustainable Energy at the UN Economic Commission for Europe (UNECE) in the areas of digital innovation, use of artificial intelligence to develop climate-neutral energy policy, and technical cooperation with former Soviet republics. Furthermore, Switzerland has been involved in the UN's International Atomic Energy Agency (IAEA). Switzerland's interests revolve around the issues of global nuclear safety and security, safeguards, technical cooperation, and support for member states using nuclear technologies, for example in the fields of medicine, water and agriculture. (Sources: Federal Council 2021c+2022b+2023d/DETEC, 2022+2023).

23 The Energy Charter Treaty (ECT) is a legally binding agreement in the energy sector between 53 states, covering investment protection and transit. The Treaty entered into force in 1998.

↗ For more detailed indicators regarding **INTERNATIONAL ENVIRONMENT** see the full monitoring report.

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