

Nuclear energy

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1 Nuclear energy

1.1 Overview over the sustainability of nuclear power plants in Switzerland

While it is a well-known fact that nuclear energy is climate-friendly, it is very important to Alpiq to ensure furthermore that it is also environmentally friendly. Scientifically substantiated statements prove the following: Nuclear energy may be slightly less environmentally friendly than hydropower, and it is no more or less environmentally friendly than new renewable energies. This is of great importance not only, but above all, with regard to Switzerland's climate protection goals. Reliable statements on the life cycle assessment of nuclear energy and other electricity generation systems used in Switzerland can be found in the report "*Potential, costs and environmental impact of electricity production plants*" published by the Swiss Federal Office of Energy in 2017 (2019 updated). It was compiled at the Swiss research centre Paul Scherrer Institute (Research Laboratory for Energy System Analyses) and is one of the the Swiss key sources when it comes to a holistic view of sustainability and Swiss electricity generation. The data is based on life cycle analyses (LCA) - i.e. the recording of all material and energy flows of the individual technologies, from the cradle to the grave. In the case of nuclear energy, this means from uranium extraction and all the necessary machines (including their construction, energy consumption and emissions) and resources (e.g. concrete, copper, steel, etc.) to the operation of the plants and the packaging and disposal of radioactive waste in a deep geological repository (including the construction and operation of the repository).

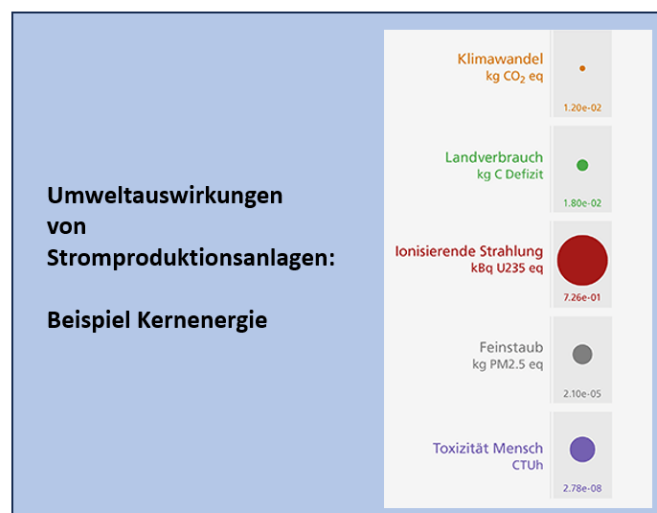


Figure 1 Environmental impact of nuclear energy production (after [SFOE 2019])

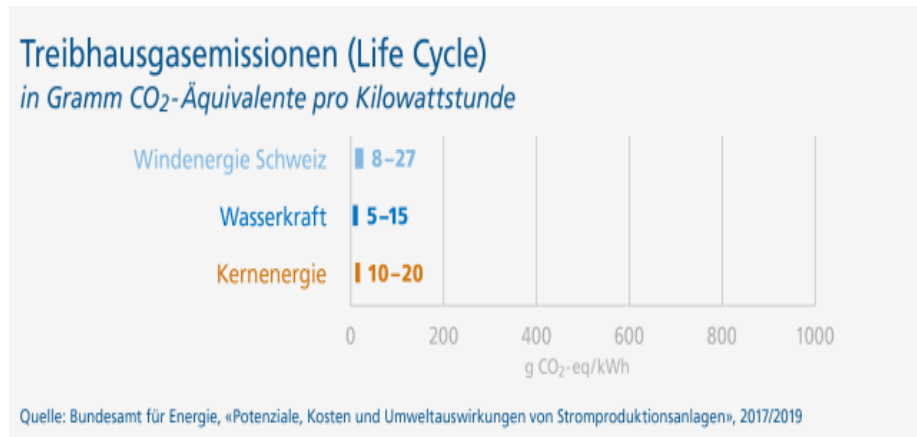


Figure 2 Greenhouse gas emissions of nuclear energy production in Switzerland (from [SFOE 2019])

Nuclear energy differs significantly from renewable energies simply because of the radioactive waste. However, it is important to note that the amount of the most active form, the high-level waste, is very small compared to the high amount of electricity generated. For example, all the high-level waste from 50 years of operation of the Swiss nuclear power plants fits into a cube with a side length of 20 metres, including the massive thick-walled packaging material. However, this small volume of fuel can be used to generate 30 to 40 per cent of domestic electricity over 50 years.

The relationship between nuclear power generation and sustainability can be most clearly differentiated and best understood by looking at the three main stages of nuclear power generation: Provision of the fuel and related resources, the actual operation of the power plant, and the disposal of spent fuel and waste. Alpiq's realization of these phases will be examined in more detail below.

1.2 „Front End“ of the nuclear energy production

The fuel required to generate nuclear energy in a nuclear power plant comes from the element uranium, which occurs in ores and is mined

Since the onset of increased instability and armed conflicts in the past few years, KKG has focused its new procurement contracts exclusively on suppliers in the uranium-rich countries Canada and Australia, as these are stable democratic forms of government and can be considered reliable partners for compliance with the demanding criteria, and the supplying companies there can be audited transparently and effectively. A comprehensive overview over the fuel procurement and movements at the nuclear power plants Alpiq holds shares in will be presented in the plants' respective sustainability reports, which are going to be published in the first half of 2024.

1.3 Operation of nuclear powerplants

The Swiss Federal Nuclear Safety Inspectorate (ENSI), which is the Swiss oversight authority responsible for Swiss nuclear power plants, assessed KKG and KKL to be safe facilities. In 2021 and 2022, all radiation protection thresholds were complied with, guaranteeing the health and safety of employees, the public, as well as third-party companies.

Regarding the stringent safety standards, reportable events at nuclear power plants do not mean that measurable quantities of radioactive substances have been released. They rather indicate that there were irregularities in operation that need to be observed and reported in accordance with the regulator's guidelines. In the nuclear power plants in which Alpiq holds shares, there were no accidents with a measurable release of radioactive material reported during 2023. Reported events were all on level zero (0 = without safety significance) according to the International Nuclear and Radiological Event Scale (INES). INES is an international convention for communicating the safety significance of nuclear and radiological events to the public (zero the lowest level and seven the highest event level).

2022	INES 0	INES 1	INES 2
Kernkraftwerk Gösgen (KKG)	6	0	0
Kernkraftwerk Leibstadt (KKL)	6	0	0

Tabelle 1 Reportable events (according to the international nuclear event scale) in Alpiq's nuclear partner plants in 2022

The use and consumption of water and waste water is defined in specific terms for KKL and KKG nuclear power plants in rules of delivery, which are monitored and approved by the regulatory authority. None of these two Swiss nuclear power plants causes significant heating of a body of water. KKG and KKL are cooled by a cooling tower. The water in the cooling towers comes from the rivers; the reinjection of cooling water introduces minor, however tolerated (by regulatory levels) amounts of heat. In hot summer weather with high river temperatures, nuclear power plants reduce their output to stay below the legal limits. In addition to power production, the KKG supplies the local surrounding industry with climate-friendly process steam which originates from its own, on-site operations - an example of re-use of own byproducts.

The following table shows the most important public source documents for a detailed presentation of the safety and environmental performance of Swiss nuclear power plants.

Document (source)	No.	Information
ENSI Oversight Report 2022	ENSI-AN-11600	Comprehensive overall safety assessment of the facilities over the reporting period (www.)
ENSI Radiation Safety Report	ENSI AN-11539	Performance of the facilities in compliance to regulation on ionizing radiation (workers doses, releases, safe handling of radioactive waste)
ENSI ANPA-EMI	ANPA-EMI KKG/KKL	Regular monitoring of radioactive discharge and emissions into water and air

Tabelle 2 Published regulatory source documents over the safety performance of Swiss nuclear partner plants (among them KKG and KKL) in 2022

1.4 “Back End” of nuclear power production

For the nuclear power plant operators, protecting the public, the employees and the environment from potential risks resulting from nuclear energy production has the highest priority. A very important aspect herein is the safe handling of radioactive waste. As a shareholder in KKG and KKL, Alpiq pays the plants’ annual costs in proportion to its share; this includes the costs of financing decommissioning and waste disposal activities. When handling radioactive waste in nuclear power plants, a distinction is made between operational waste and spent fuel elements and waste from reprocessing.

After its use in the nuclear reactor, spent nuclear fuel is encapsulated in containers following unloading from the reactor and is transferred to the National Intermediate Storage Facility (Zwilag), a secured site managed by the nuclear plant owners (one of them being Alpiq), where it cools further until preparations for a final geological disposal facility will be finalized. The Swiss organisation commissioned to develop and implement this deep geological repository, Nagra, is following the Swiss government's staged implementation plan. In September 2022, Nagra published a decision on a preferred site for a deep geological repository on a scientific basis. This proposal is currently being further consolidated and evaluated in accordance with the governmental step-by-step implementation plan. A comprehensive overview over the waste volumes and movements at the nuclear power plants Alpiq holds shares in will be presented in the plants’ respective sustainability reports, which are going to be published in the first half of 2024.

The financing for dismantling nuclear power plants and for the safe disposal of radioactive waste is secured. To ensure the financial responsibility is adequately managed, the nuclear power plant operators pay into the funds for decommissioning and disposal (STENFO) on an ongoing basis. These funds are subject to federal supervision. In 2022, KKG paid CHF 2.7 million and KKL CHF 7.7 million (in 2023 the same sums, according to a provisional assessment, were due) into the funds for decommissioning and waste disposal. The payments made into the funds are calculated on the basis of cost estimates prepared every five years for decommissioning and dismantling nuclear power plants and for disposing of nuclear waste.