An analysis on the export capability of neighbouring countries until 2035

On Switzerland's future import capability

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Content

Background

The nuclear phase-out in Germany in 2022 is followed by a coal-phase out until 2038. In France, President Macron is planning to reduce nuclear power's share of the electricity mix to 50% by 2035. Closure of the Fessenheim nuclear power plant, from which Axpo also purchased electricity for a long time, will be starting next year. This leaves one with the question what these developments in neighbouring countries mean for Switzerland.

Switzerland is dependent on electricity imports, especially in winter. Most of them come from France and Germany, where significant secure capacities will disappear from the market over the coming years. Although large amounts of new wind and photovoltaic capacities are deployed, wind and solar electricity generation is fluctuating. At the same time, sector coupling is becoming increasingly important: oil and gas heating systems are to be replaced by heat pumps in the heating sector and e-mobility is replacing the use of internal combustion engines in the mobility sector. Thus, once can expect an increase in demand for electricity.

Therefore, the role of electricity is gaining in significance. This is also increasing the importance that electricity supply plays as a (geo-)strategic resource for nation states. Switzerland has been negotiating the bilateral electricity agreement with the EU for years; the outcome remains uncertain. Furthermore, Switzerland's future import capability depends primarily on further existence and expansion of transmission grid capacities and the export capability of surrounding countries.

The Energy Economics department has taken a closer look at the export capability of surrounding countries, analysing it in various scenarios up until 2035. Unlike most European countries, Switzerland has sufficient capacity at all times to meet demand during peak periods thanks to its hydro reservoirs in the mountains. However, not enough electricity is produced in winter to provide Switzerland with a self-sufficient supply for an extended period of time. The domestic reservoirs would empty soon enough, which is why Switzerland has an energy problem rather than a capacity problem. And this is precisely why the export capability of surrounding countries is extremely important to Switzerland. While Switzerland doesn't depend on this export capability at all times, it does need neighbouring countries to supply it with electricity in winter months.

Methodology

To analyse developments over the next 15 years, assumptions with regard to the expected demand, the developing power plant portfolio and the expansion of transmission capacities have to be taken.

Assumptions on the development of power demand, power plant portfolio and transmission grid capacities

The Energy Economics department is assuming the following (in its view, the most likely case for Switzerland): an increase in power demand of just under 1% per year, expansion of transmission grid capacities in accordance with the ten-year network development plan drawn up by ENTSO-E (the European Network of Transmission System Operators for Electricity) and a moderate expansion of renewable energies. The latter reflects a rather conservative assumption. Although electricity generation from photovoltaic installations will more than double by 2035, more would be necessary to meet a development such as that envisaged in the Energy Strategy 2050. Only limited potential is expected for the expansion of wind power and hydropower.

Six possible scenarios are being examined. Three of them assume ‘average conditions’. In other words, average availability of both conventional power plants and renewable energies and average power demand within Switzerland and abroad is expected.

In the other three cases, ‘unfavourable conditions’ are examined. To this end, a 15 days lasting cold ‘Dunkelflaute’ is simulated for every month. A Dunkelflaute describes a weather phenomenon during which wind and photovoltaic installations virtually cease generation due to low winds and dense clouds. When at the same time cold temperatures contribute to a high electricity demand, energy economists speak of a cold Dunkelflaute

Assumptions on the cold Dunkelflaute

For the purpose of the analysis, three cases expect cold, cloudy and windless weather lasting half a month and average conditions for the other half of the month, for each month. For the cold, cloudy and windless period of weather, the lowest daily availability of wind and photovoltaics measured in the last ten years during the month in question is carried over to the entire half-month period. If, for example, the lowest daily availability for April has been 5% in recent years, then 5% is used for a full 15 days in April to accordingly reflect the ‘unfavourable conditions’. For hydropower, the lowest monthly availability measured over the last ten years is used instead of the lowest daily availability. The same applies to the load, but the highest measured monthly load is used here.

In the context of the ‘average’ and ‘unfavourable’ conditions, two sensitivities with regard to the availability of nuclear power are considered. What is being carried out is therefore a kind of stress test. In the ‘average conditions’ base case, a conservative estimate of 90% availability is made, while 85% availability is presumed in the ‘unfavourable conditions’ base case.

1. Sensitivity: availability of nuclear power in Switzerland only 50% (equivalent to Gösgen or Leibstadt and one block at Beznau being unavailable)
2. Sensitivity: availability of nuclear power in Switzerland and France only 50% each

Scenario	**1**	**2**	**3**	**4**	**5**	**6**
Conditions	Average	Average	Average	Unfavourable	Unfavourable	Unfavourable
Nuclear power (CH)	90%	50%	50%	85%	50%	50%
Nuclear power (FR)	90%	90%	50%	85%	85%	50%

To calculate the import capability, the scenario-specific surplus production of surrounding countries is determined first of all. It is assumed that half of this surplus production – i.e. the difference between national production and consumption – is available to Switzerland as imports. Furthermore, Switzerland’s ability to import is naturally also limited by the transmission grid capacities to Switzerland.

Results

The charts below show Swiss electricity generation minus Swiss demand in addition to possible imports on a monthly basis over the period from 2010 to 2035 in the various scenarios.

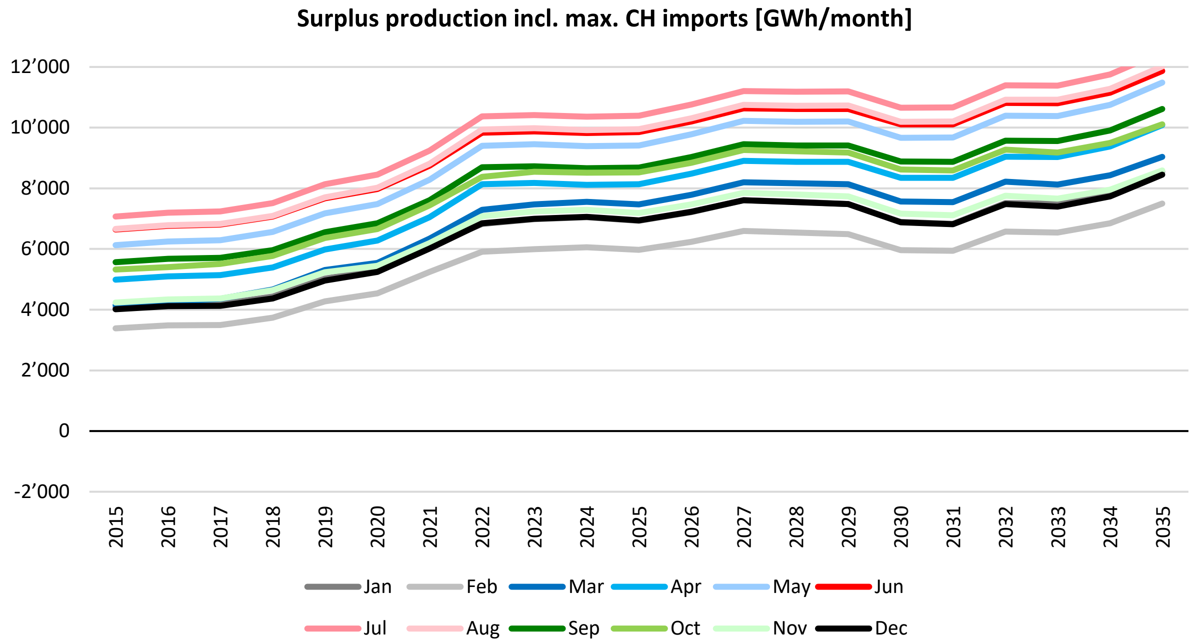

Figure 1: Surplus production including imports under average conditions

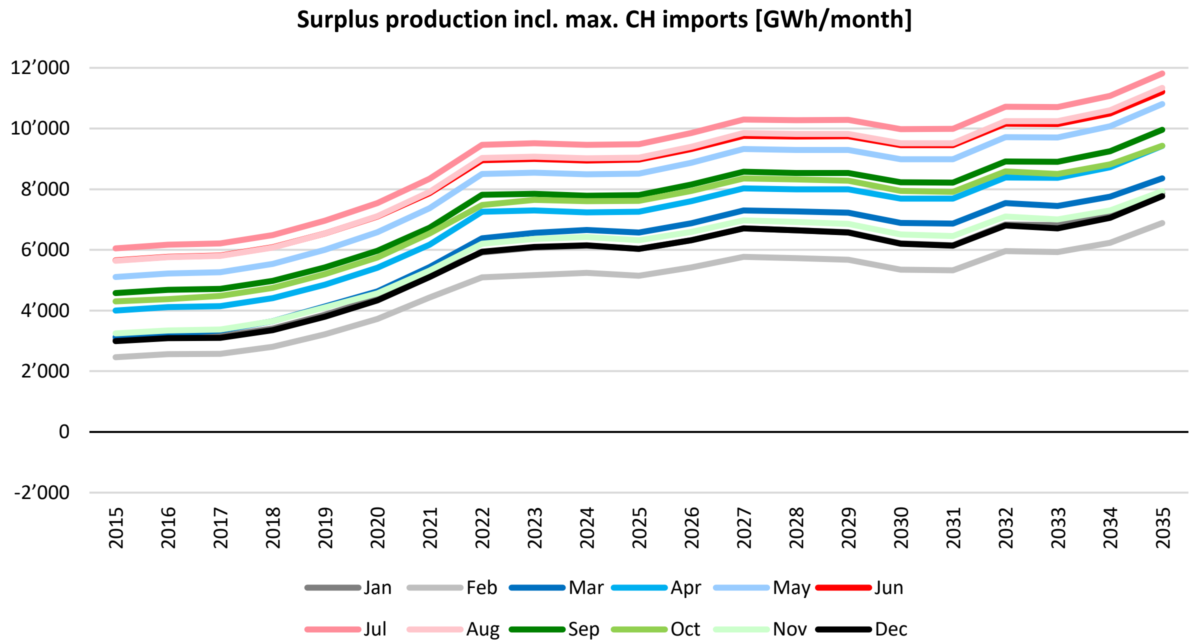

Figure 2: Surplus production including imports at 50% nuclear power availability in Switzerland and under average conditions

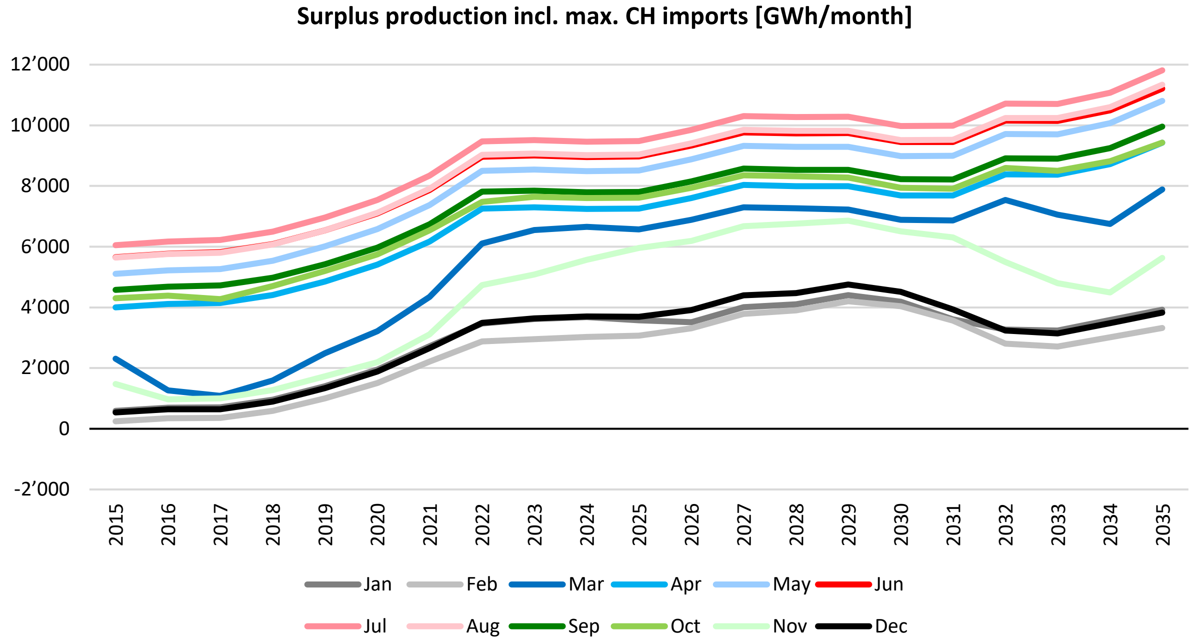

Figure 3: Surplus production including imports at 50% nuclear power availability both in Switzerland and France and under average conditions

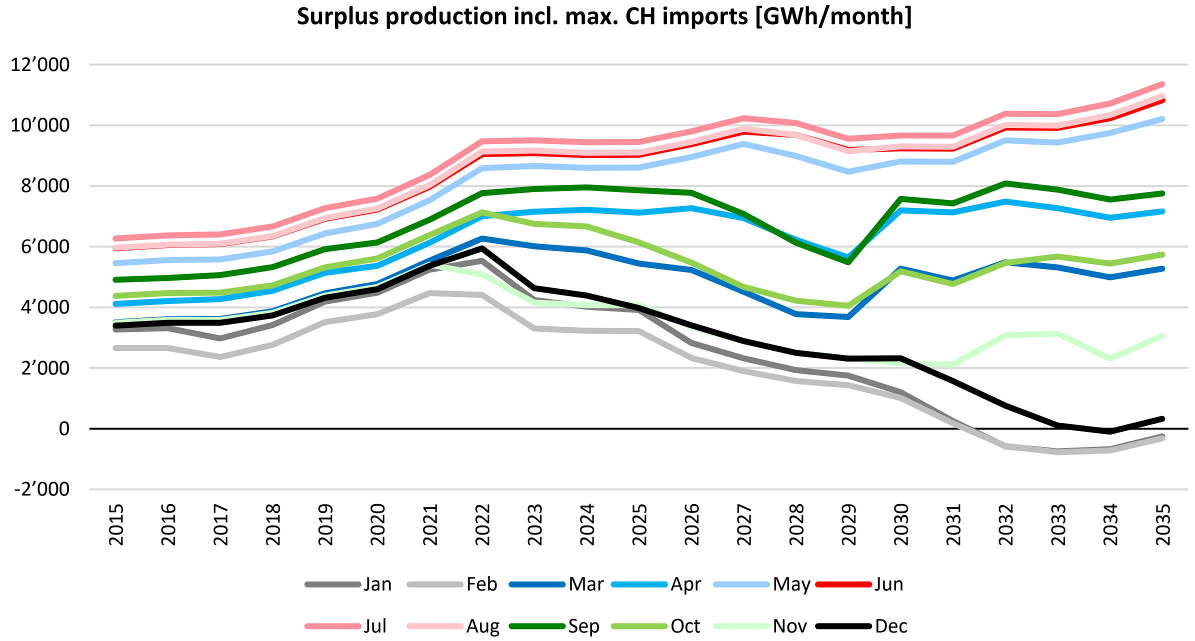

Figure 4: Surplus production including imports under unfavourable conditions

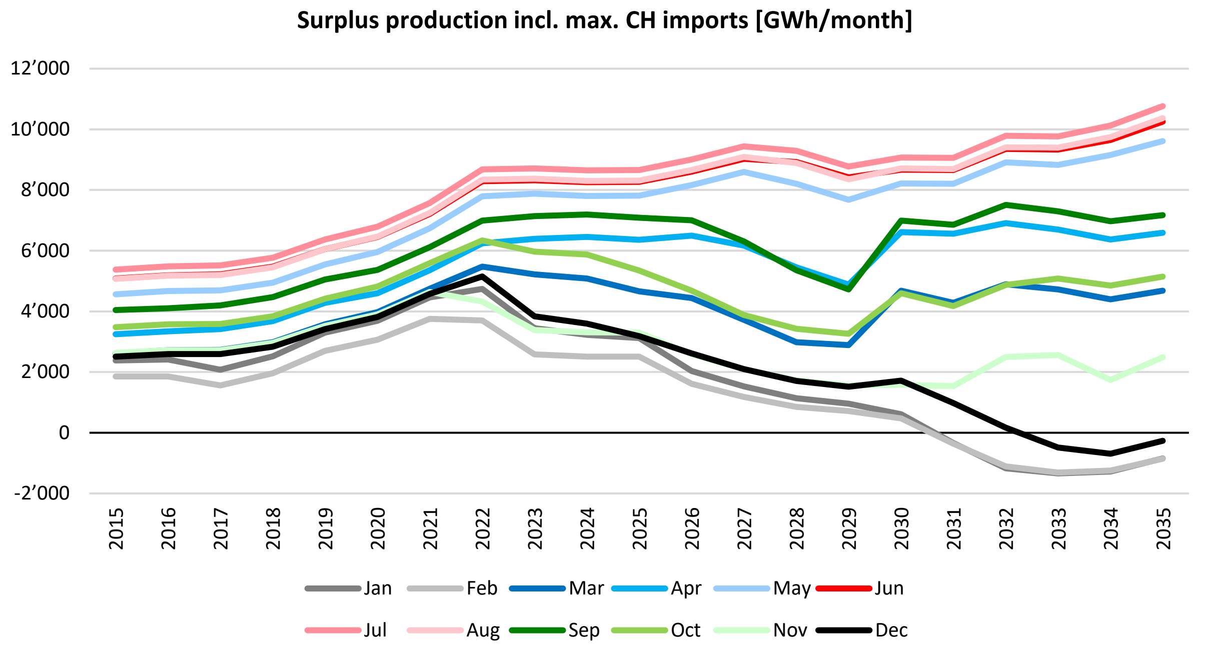

Figure 5: Surplus production including imports at 50% nuclear power availability in Switzerland and under unfavourable conditions

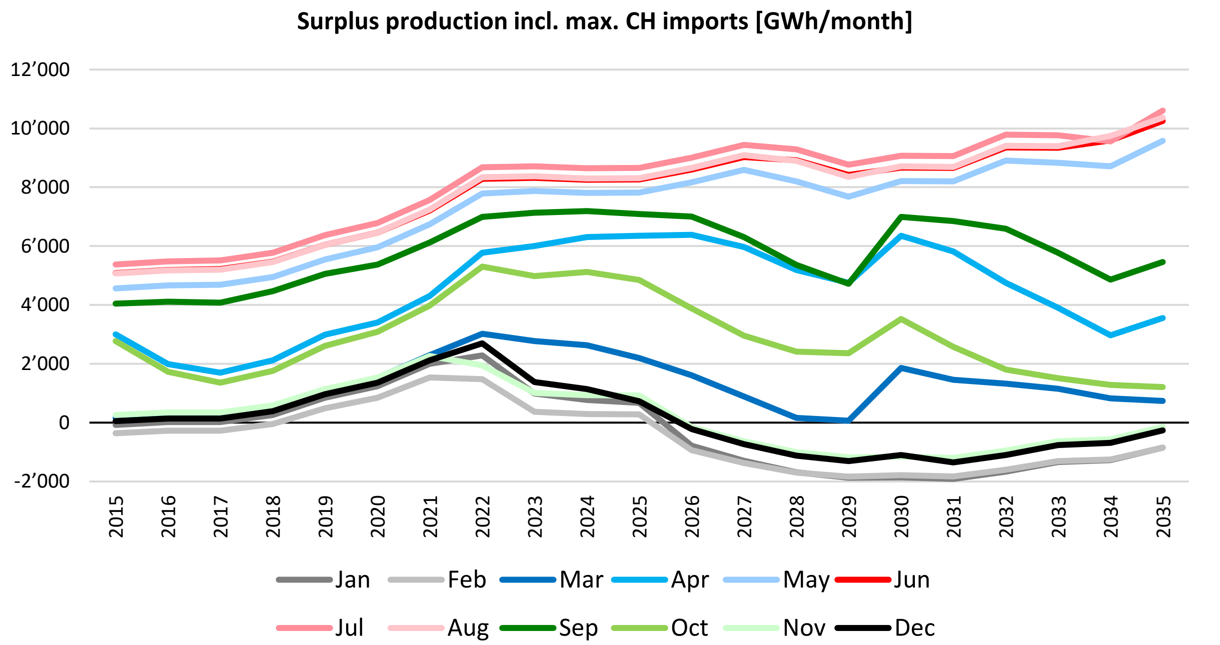

Figure 6: Surplus production including imports at 50% nuclear power availability both in Switzerland and France and under unfavourable conditions

Conclusion

It is evident that the electricity supply in Switzerland very much depends on imports. Even in the most favourable scenario under 'average conditions', a secure electricity supply cannot be achieved in the months of November to March without imports. Other studies have shown that the supply risk in the event of a half-month shortfall in imports can be minimised by changing how Swiss storage power plants are used[1]. Yet that is not sufficient for a long-term electricity self-sufficiency, which would be economically disadvantageous, anyhow and ought not to be the objective. Taking electricity imports into account, no electricity shortages are expected in Switzerland under 'average conditions' until 2035. This holds true even if parts of nuclear power in Switzerland and/or France are unavailable, as the sensitivity calculations show.

In case of 15 days lasting Dunkelflauten as illustrated in the 'unfavourable conditions' scenarios, critical situations may arise from 2030 onwards – even with electricity imports from abroad. If additional nuclear power capacities in Switzerland or France were to be unavailable or even be shut down entirely, this would exacerbate the situation. In the worst-case scenario, where nuclear power capacities in Switzerland and France are unavailable and there are cold Dunkelflauten, an energy deficit is likely for the months of November to February. This shortfall could, however, be countered by changing the way Swiss storage power plants are operated resulting in no shortage of supply overall. This would require adjustments to the regulatory framework. The storage reserve proposed by the Federal Government represents one possible approach. In addition to maintaining a storage reserve, concluding the bilateral electricity agreement could also be conducive to viable electricity exchange.

During the summer months, when Switzerland generates more electricity than it consumes, there are no electricity bottlenecks, even in the most unfavourable case examined.

Overall, the study illustrates that Switzerland's ability to import electricity – assuming viable electricity exchange with neighbouring countries (i.e. existing transmissions capacities can continue to be used and will be expanded as currently planned) and, if necessary, an adjustment to how storage power plants are operated – is likely to continue in the years to come. Nevertheless, one should continue to monitor developments.

[1] See *Michael Beer and Rainer Kyburz. Mit Speicherwasser gegen die Dunkelflaute. [Using stored water to fight cloudy and windless weather.] Bulletin SEV/VSE, 2019(10):51--56, October 2019. [pdf]*