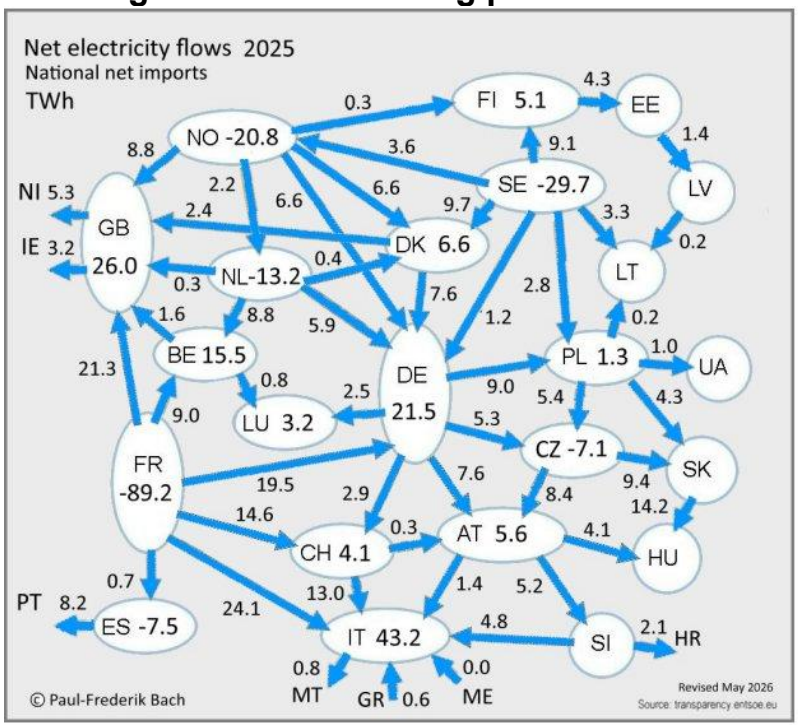
European overview 2025

International interconnection of electricity systems began early with bilateral agreements that were intended to provide capacity savings, better utilization of energy resources and improved security of supply. The interconnection of European electricity markets provided better operational optimization, but also increased pressure on the grids.

This paper is a summary of European data from 2025.

Exchanges in 2025: Growing pressure on transmission networks



Net imports TWh				
	2025	2024	2023	2022
FR	-89,2	-87,3	-48,7	16,2
SE	-29,7	-33,5	-28,6	-33,0
NO	-20,8	-17,9	-17,1	-12,0
NL	-13,2	-4,2	-5,4	-4,2
ES	-7,5	-7,5	-12,0	-18,2
CZ	-7,1	-6,4	-9,1	-14,2
SI	-1,7	-2,5	-4,8	0,3
LV	1,2	1,1	0,8	2,3
PL	1,3	1,9	3,9	-0,9
EE	2,9	2,9	3,3	1,0
LU	3,2	3,6	3,5	3,9
LT	3,7	5,7	7,5	8,8
CH	4,1	-12,0	-5,1	3,8
FI	5,1	3,2	1,7	12,3
AT	5,6	-4,8	1,7	9,7
DK	6,6	3,8	3,3	1,6
BE	15,5	13,5	2,9	-6,3
DE	21,5	22,1	8,6	-27,6
UK+IE	34,5	39,5	27,4	-4,0
IT	43,2	49,7	50,8	43,2

Fig. 1 - European exchange pattern 2025 and national net imports 2022-2025

An interdependence has gradually emerged between the power systems of European countries. Some countries have become major suppliers of energy. In 2025, these were France, Sweden, Norway, the Netherlands, Spain and the Czech Republic (Fig. 1).

Random events can affect individual countries, causing them to change roles from year to year. This applies, for example, to France, which was a significant importer in 2022. Major changes have also occurred for Belgium and the United Kingdom. Germany's phase-out of nuclear power was not random, but had an impact on exchanges throughout Europe.

In addition, the growth of wind and solar energy has increased traffic pressure in both internal networks and on interconnections.

A later section shows the development of the production mix for 20 countries in Europe since 2019. Here, the traces of the natural gas crisis in 2022 will also be visible. The big question is whether it will be possible to develop the overall European power system in the desired directions in a reasonable time. This applies to climate neutrality and robustness with regard to energy suppliers, economics and operational reliability

Electricity markets in 2025: More flexibility needed

The European electricity markets are divided into bidding zones (Fig. 2). Until October 1, 2025, a spot price per hour was set for each bidding zone. After that, prices were set for each quarter.

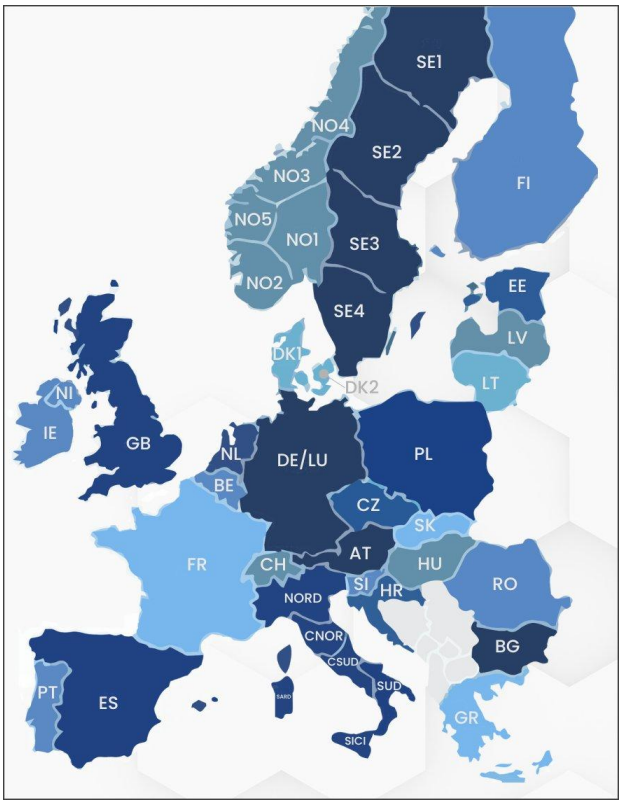


Fig. 2 - EU spot market bidding zones

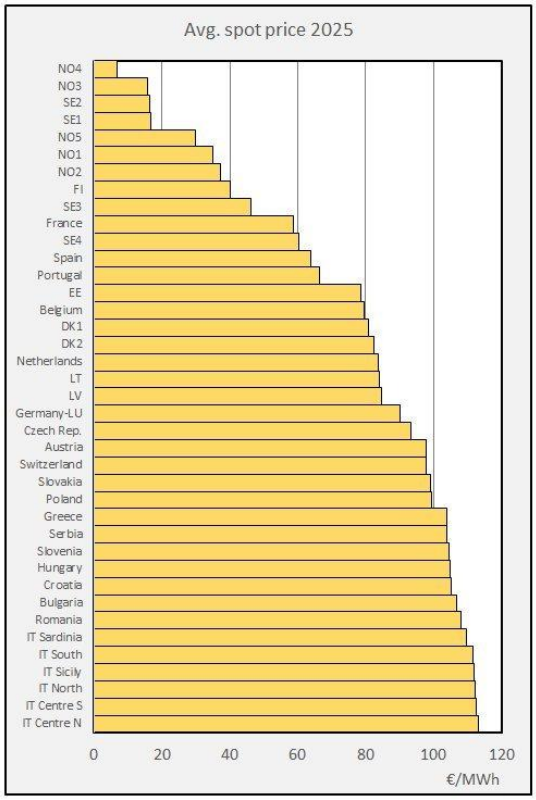


Fig. 3 - EU average hourly spot prices 2025

Limits are set on the amount of power that can be transferred between two bidding areas. If the market wants more to be transferred than the current capacity, this is a bottleneck that gives the bidding areas different spot prices.

As described above, the pressure on the grid bottlenecks has increased. The average result for the entire year will be very different market prices for electricity (Fig. 3). The lowest prices are found in areas with production surpluses, which, due to grid constraints, cannot reach areas with a greater willingness to pay. The intention is of course to move demand to areas with low prices.

If there were no bottlenecks in the transmission grid, all areas should have the same price. This is not a realistic option. This would result in very low utilisation of the grid and thus unreasonable overinvestment. New lines must fit into an overall grid structure, and they should each have a reasonable economic justification. The price differences are necessary, but it is always debatable whether the transport capacity is appropriate.

Germany has internal bottlenecks that could be managed rationally if the country were divided into at least two bidding areas. Since it is important for the Germans to have the same price throughout the country, traffic must instead be redirected with money (redispatch). In Fig. 1 you can see how traffic is being pushed eastwards from Germany and southwards from Poland and the Czech Republic towards Austria and Hungary. This is traffic that

Germany's neighbours are limiting with technical means (phase shifting transformers) because they believe that the Germans should solve their own network problems.

The electricity markets must also handle the short-term fluctuations caused by variations in wind and solar power.

It requires correspondingly flexible resources in the form of production and consumption to absorb these fluctuations. The development of flexible consumption is making only little progress, and the introduction of wind and solar power is pushing away controllable production.

Instead, the markets react with large fluctuations in market prices (volatile prices).

Overproduction manifests itself as negative spot prices. Business areas are constantly being developed to compensate for these imbalances. This can include stopping the production of wind and solar energy for a fee and in Denmark now also with 1 MW "toasters" that heat the air to no avail. It should be obvious that it is important to limit the extent of these emergency solutions.

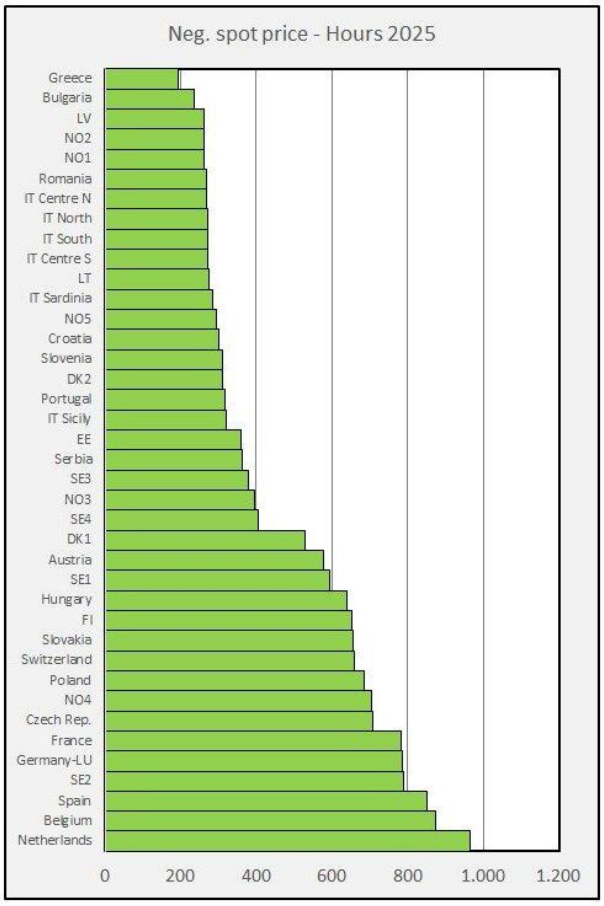


Fig. 4 - Number of hours with negative spot prices.

Solar energy is produced in relatively few hours in the middle of the day. It initially provided good income, but when investors flocked, market prices began to decline in the middle of the day. Professional investors should have been able to predict this, but in Denmark it surprised most people, resulting in large losses and bankruptcies.

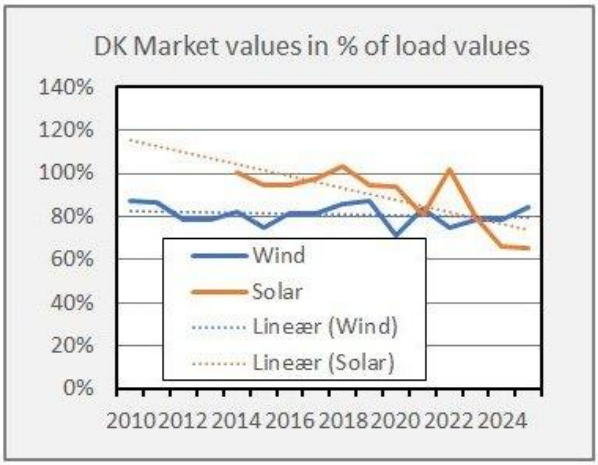


Fig. 5 - DK relative market values of wind and solar energy. Demand = 100%.

Fig. 5 shows that the market value of solar energy began to decline around 2020, with the exception of the crisis year 2022. The market value of wind energy is more constant because wind energy production is randomly distributed throughout the day. The recognition of this problem leads to plans to install batteries as part of individual solar parks.

Market prices and not least negative electricity prices are warnings of serious imbalances between production and consumption in most countries. Better stability and predictability must

be achieved by systematically developing more flexibility in both production and consumption as a prerequisite for continued expansion of wind and solar power.

European power 2019 to 2025: Nuclear power is indispensable

For 20 European countries, data has been collected for electricity production by fuel type in the years 2019 to 2025. Since the oil crisis in 1973, Europe's dependence on unstable supplier countries has been well known. The decisions made at that time shifted the dependence to other countries, which are also not as stable as one would wish. This became evident during the gas crisis in 2021-2022.

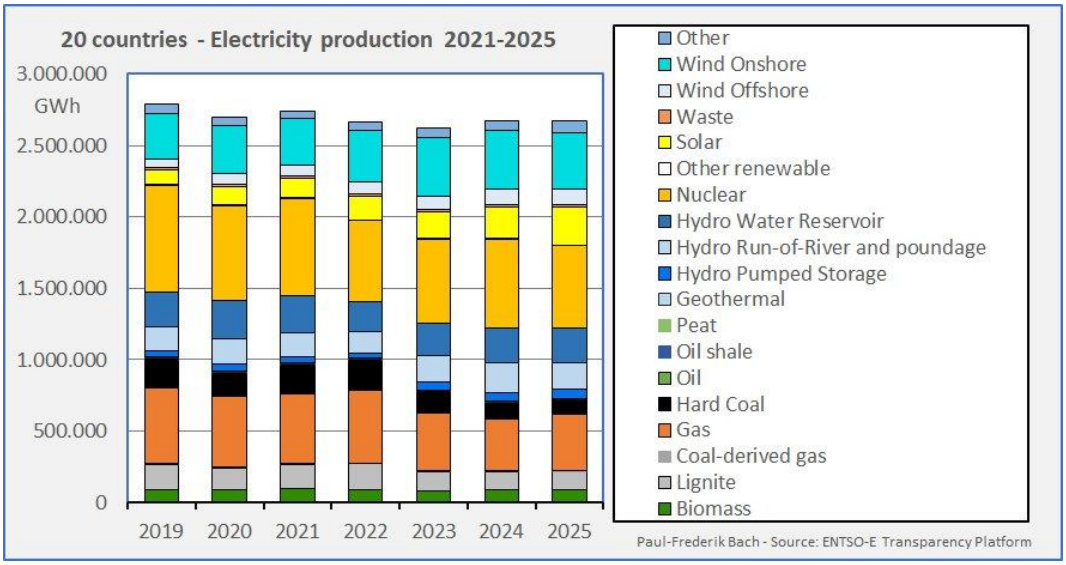


Fig. 6 - Production mix for 20 European countries 2019 to 2025

Total electricity consumption for the 20 selected countries has decreased slightly (4%) in 6 years. The share of fossil production has decreased from 33% to 24%. Wind and solar energy have grown from 17% to 29%. Nuclear power has decreased from 27% to 22%, but still makes up the largest contribution on the list. Most of the decrease is due to the shutdown of German nuclear power, which in 2019 delivered 71 TWh. In comparison, 123 TWh were produced from lignite and 99 TWh from coal in 2025.

The changes are happening slowly. With linear extension, the use of fossil fuels could be phased out by 2040, while wind and solar energy could have grown to about 60%. How should this be balanced, and what should the rest consist of?

It is difficult to imagine a stable electricity supply in 2040 without nuclear power. This may be the reason why several European governments are reconsidering the future of nuclear power. This is the case for example in Sweden and Belgium.

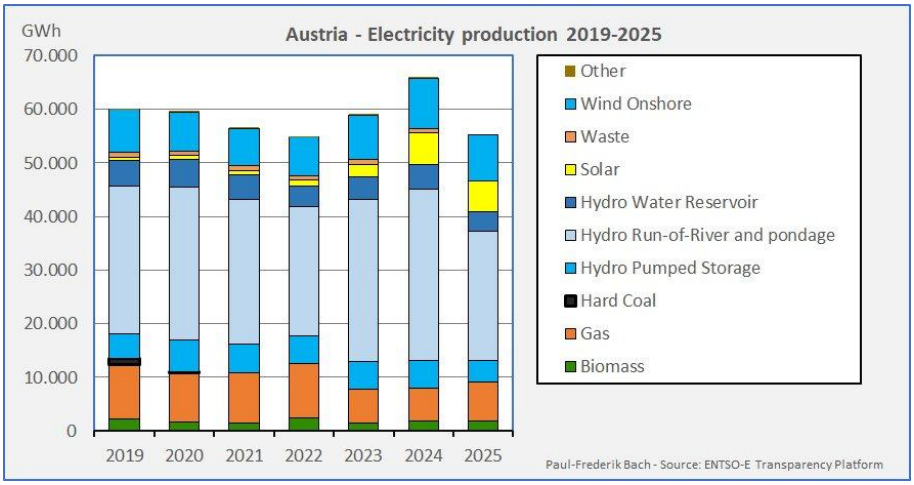
For a few countries, the ENTSO-E data was clearly incorrect and could not be used.

Austria
Belgium
Switzerland
Czech Republic
Germany
Denmark
Spain
Finland
France
United Kingdom
Lithuania
Latvia
Estonia
Netherlands
Norway
Italy
Poland
Portugal
Sweden
Slovenia

Table 1 - The 20 countries

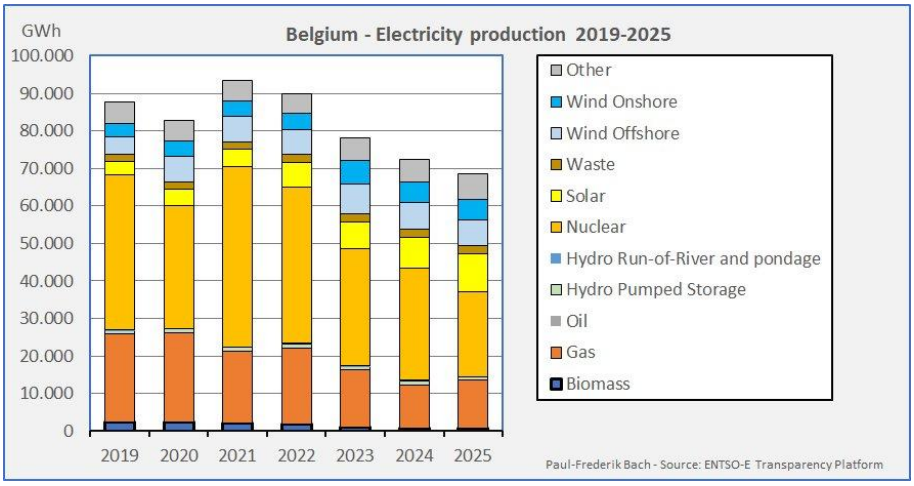
20 countries' production mix

Austria: More than 50% electricity from hydropower



In 2025, 81% of electricity consumption could be covered by renewable energy sources, 7% by imports and 12% by fossil energy (natural gas). Wind energy accounted for 14% of consumption and solar energy 10%. Hydropower covered over 50% of consumption in 2025, but the ability to regulate is limited because the country's water reservoirs are relatively small ("pondage"). The Austrian water reservoirs hold approximately 2 TWh (3% of annual consumption), while the Norwegian ones hold approximately 83 TWh, by comparison. Hydropower energy production can vary from year to year. Austria had a net export of 4 TWh in 2024 and a net import of 5 TWh in 2025.

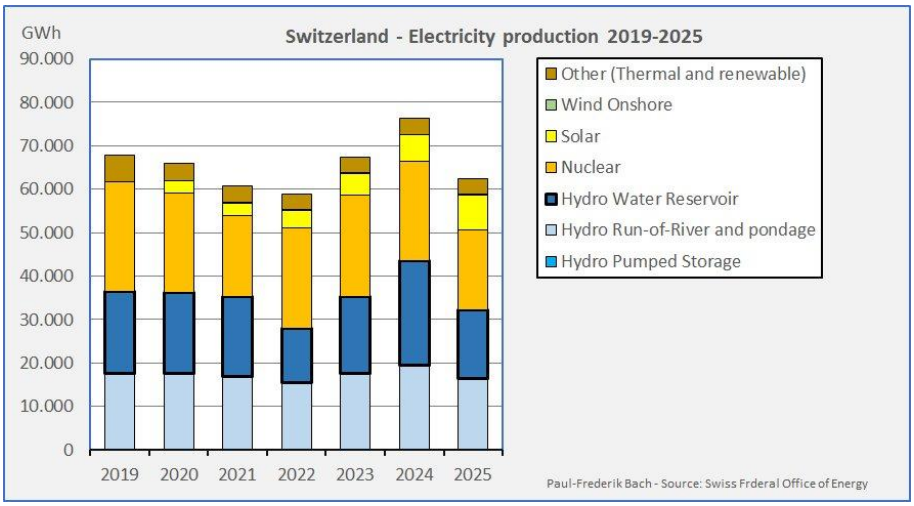
Belgium: Strong appeal from TSO to Belgian politicians



Belgium's annual electricity consumption is around 80 TWh. Since 2021, the annual balance has developed from a surplus of 9 TWh to a deficit in 2025 of almost 12 TWh. Nuclear power has played a significant role in Belgium, but in 2003 the federal government decided on a phase-out plan to be implemented between 2015 and 2025. However, the plan has been revised so that the two newest units from 1985 are still in operation. Overall, Belgium still has 2056 MWe of nuclear power in operation, while 3876 MWe have been shut down. A new government has again changed the law, which now allows new nuclear power, including SMR. Belgium exported 6.3 TWh in 2019. In 2025, 15.5 TWh were imported. A study by the Belgian TSO, ELIA, underlines the need for urgent decisions on long-term goals. In order to meet the climate goals in 2050, a sharp increase in electricity consumption is expected. ELIA emphasizes that there are no easy solutions. Regardless of what is chosen, implementation will be difficult.

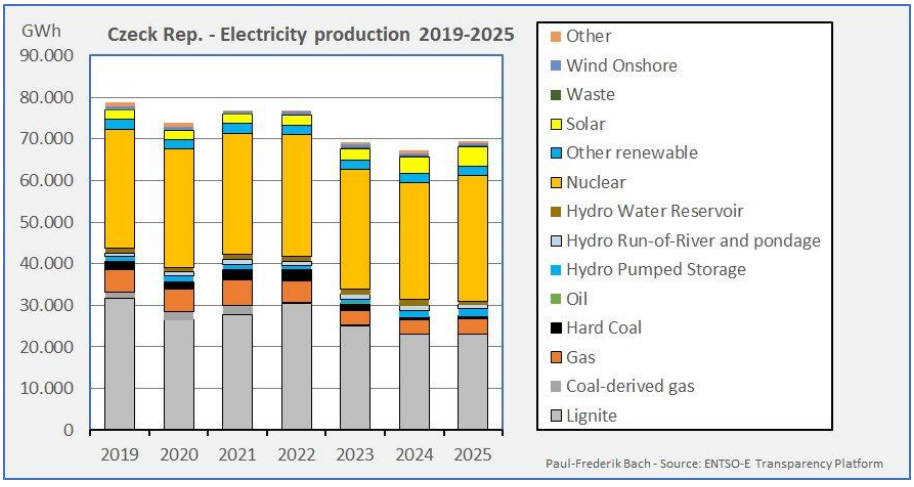
Switzerland: Will the phase-out of nuclear power be canceled?

For Switzerland, errors were found in hydropower data from Entso-e. Data was instead obtained from the Swiss Federal Office of Energy.



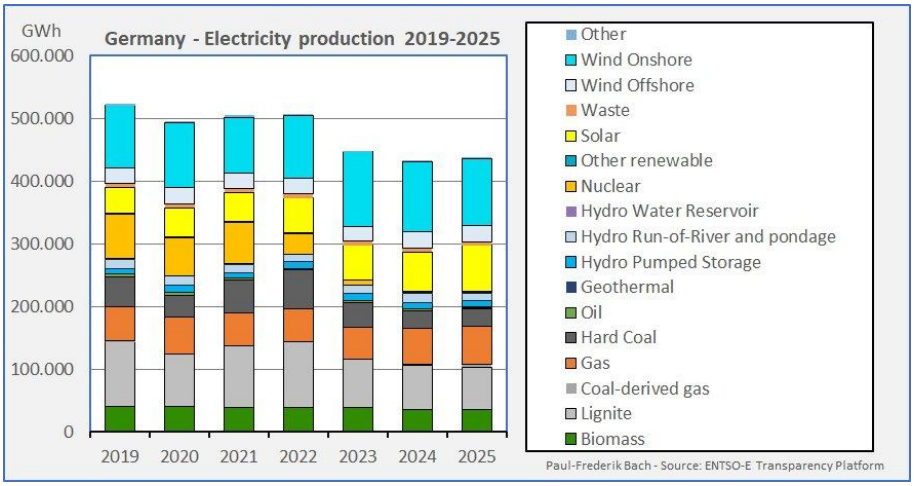
The annual electricity consumption in Switzerland has varied between 60 and 63 TWh, so there has been a nice production surplus in most years. Hydropower and nuclear power have dominated production, but with a growing contribution from solar energy. It is the nature of hydropower that production can vary from year to year. In 2025, the distribution was 52% hydropower, 29% nuclear power and 13% solar energy. Due to hydropower, Switzerland has always played a central role in regulating the frequency of the continental electricity grid. For this purpose, the Swiss water reservoirs of approximately 7 TWh are not that much, especially if compared with the Norwegian water reservoirs of 83 TWh. Switzerland cannot therefore store energy from year to year to the same extent as Norway. A modest growth in electricity consumption in Switzerland is expected towards 2050. It has been decided to phase out nuclear power as the lifespan of existing plants expires. Instead, various forms of renewable energy will be installed. This plan may have raised doubts. On August 28, 2024, the Federal Council decided on a new nuclear energy policy that will make it possible to lift the current ban on new nuclear power. The proposal was forwarded to parliament in August 2025. Developments can be followed in an annual Monitoring Report.

Czech Republic: 48% nuclear energy and 37% lignite in 2025



The Czech Republic's annual electricity consumption has fallen from 66 TWh in 2019 to 63 TWh in 2025. At the same time, production has fallen somewhat more, so the Czech Republic's annual net exports have fallen from 15 TWh to 10 TWh. Nuclear energy production accounted for 48% of consumption in 2025, while lignite-fired production accounted for 37%. The third largest group in 2025 was solar energy with 8%. Since 2019, there has been a significant decrease in the consumption of lignite. The plan is to phase out coal-fired plants and replace them with new nuclear power and renewable energy by 2035.

Germany: Doubts about meeting climate targets in 2030



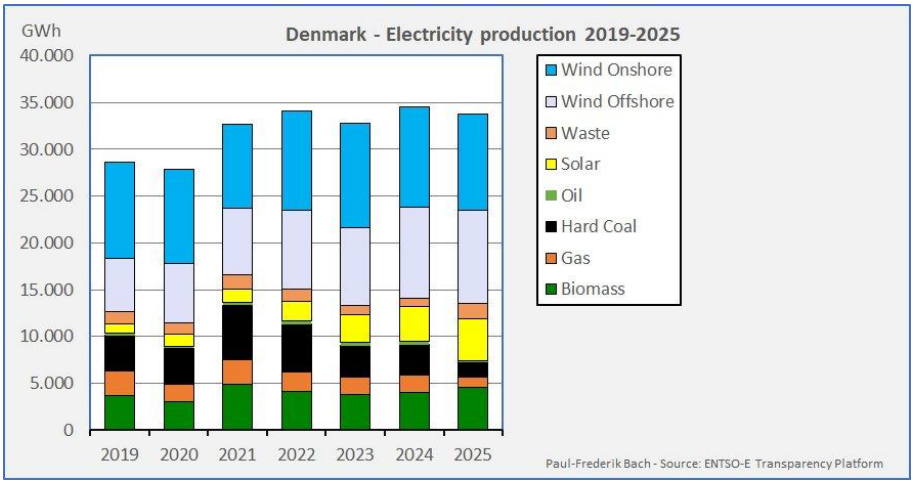
Due to its size and location, Germany is an important part of the European electricity market, but Germany has unfortunately become a weak link. This is for several reasons:

- The phase-out of nuclear power in Germany has changed the country from having a significant surplus of electricity production to a country that is heavily dependent on imports from other countries.
- The need for transport of large amounts of non-dispatchable electricity from north to south exceeds the capacity of the grid. Strengthening the grid is difficult and expensive, and it is going far too slowly.
- Since Germany does not want to divide the country into price zones as in the Nordic countries and Italy, the result is market prices that provide the wrong incentives and thus sub-optimal operation in large parts of Europe, not least in the Nordic countries.

Germany's electricity consumption has been falling to 465 TWh in 2025, but the electricity savings were not enough to offset the decline in production. Fossil production was 35% of consumption in 2025. 14% was produced with lignite. Germany's goal is to achieve climate neutrality by 2045. On May 18, 2026, the German "Expert Council for Climate Issues" published a report concluding that the country's greenhouse gas emission targets for 2030 will probably not be met.

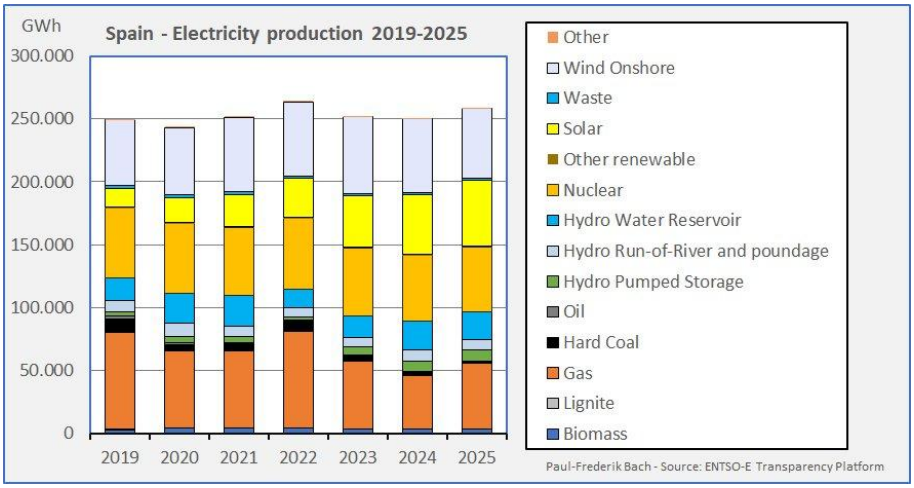
Denmark: Prospects for stronger ties with Germany

Denmark's electricity consumption has grown from 34 TWh in 2019 to 38 TWh in 2025. There has been an average production deficit of 3.4 TWh in each of the years shown. During the gas crisis in 2021, production was increased significantly using biomass, gas and coal. Since then, the consumption of coal and gas has been reduced in line with increased production of electricity



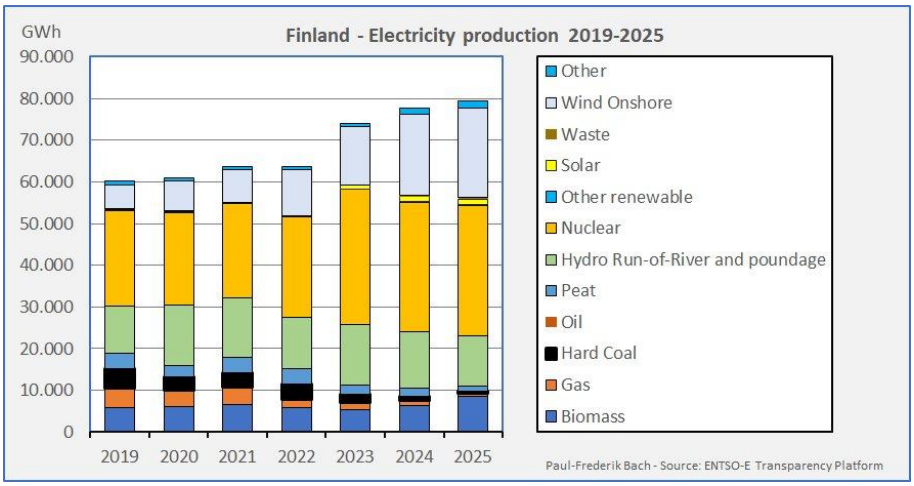
from solar and offshore wind. In 2025, onshore wind accounted for 28% of consumption, offshore wind 27%, solar 12% and biomass 12%.
Coal and gas together covered 12% and net imports 12%. Compared to most other countries, Denmark has achieved a high share of renewable energy in electricity production. The other side of the coin is a rather low share of dispatchable production, formally around 25%, in practice probably somewhat less. Denmark has become dependent on support from neighboring countries due to the uneven renewable production. This has created a need for extra transmission capacity to compensate for the imbalances. It has always been the intention that new flexible consumption should absorb the fluctuations. It should have been developed at the same time as the expansion of wind and solar energy, but it still seems to have long prospects. After the commissioning of the west coast line to Germany, the electricity market in Western Denmark is even more closely linked to the German electricity market. It is therefore doubtful whether the new supply of offshore wind in Denmark will have any influence on prices on the Danish electricity markets, as has been claimed in the discussion of the new projects.

Spain: Blackout in 2025 due to neglected voltage regulation



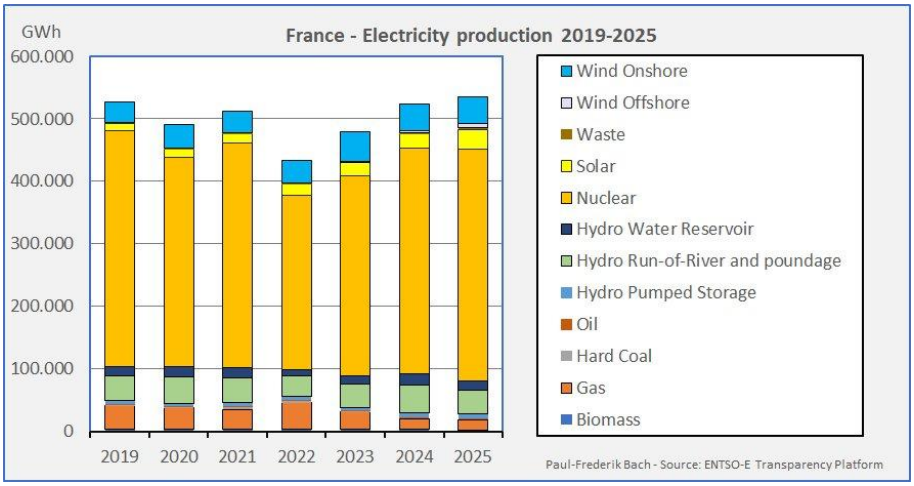
Spain's power system is diverse. In 2025, electricity production consisted of 23% onshore wind, 22% solar energy, 22% nuclear power, 22% gas and 13% electricity from hydropower. In addition, Spain, with 13 TWh, has by far the largest water reservoirs in Southern Europe. Over the past 6 years, there has been significant growth in solar energy and a steady decline in gas consumption, the latter except for the crisis year of 2022. Spain and Portugal together form a large power system in relation to the connection to France. A blackout on 28 April 2025 affected the entire Iberian Peninsula and therefore attracted a lot of attention and also triggered comments that too many solar cells had probably been installed. However, this can clearly be rejected. A comprehensive report from ENTSO-E neatly encapsulated the reasons. It was an overvoltage collapse, which was due to insufficient resources for voltage regulation and perhaps also insufficient focus on this important issue.

Finland: Only 3% fossil energy in electricity production by 2025



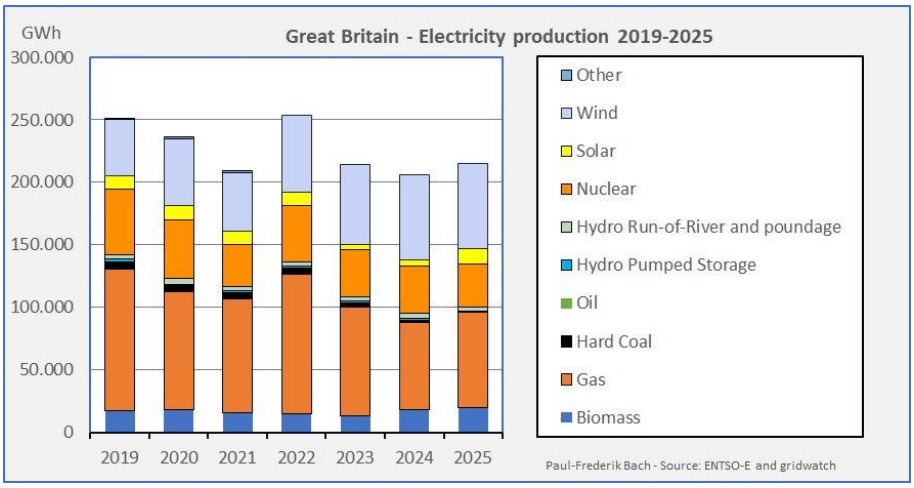
In 2025, Finland's electricity production from fossil fuels accounted for only 3% of electricity consumption. This is a result that deserves respect when you consider the difficulties that Finland has had to contend with. The most important energy sources in 2025 were nuclear power 37%, onshore wind 25%, hydropower 14%, biomass 10% and solar less than 2%. Finland's annual electricity consumption varies around 80 TWh. Up to and including 2022, Finland imported up to 9 TWh per year from Russia. Fortunately, the new nuclear power unit, Olkiluoto 3 with a capacity of 1600 MW, was finally put into operation in 2023. Finland's growth in wind energy is also remarkable, with production reaching over 21 TWh in 2025. Critical supply situations have occurred in January. It can get quite cold in January, and a lot of electricity is used for heating. Both nuclear power and wind have delivered stably in the most critical situations.

France: Surplus of electricity for the rest of Europe



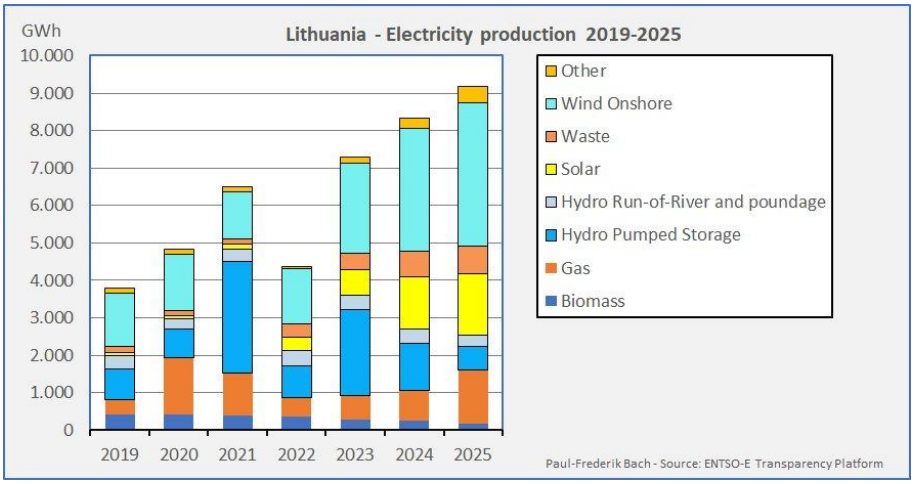
France's annual electricity consumption has fluctuated quite a bit between 425 and 465 TWh. In 2025, nuclear power covered over 85% of electricity consumption. France has a large fleet of nuclear power plants, many of which suffered the same fault in 2022, which took several years to fix. That year, France was a net importer of electricity. Coinciding with the international gas supply crisis, it was a difficult year for many European countries. Except for 2022, France has been Europe's major supplier of electricity, as shown in Fig. 1.

Great Britain: Too important to be left out



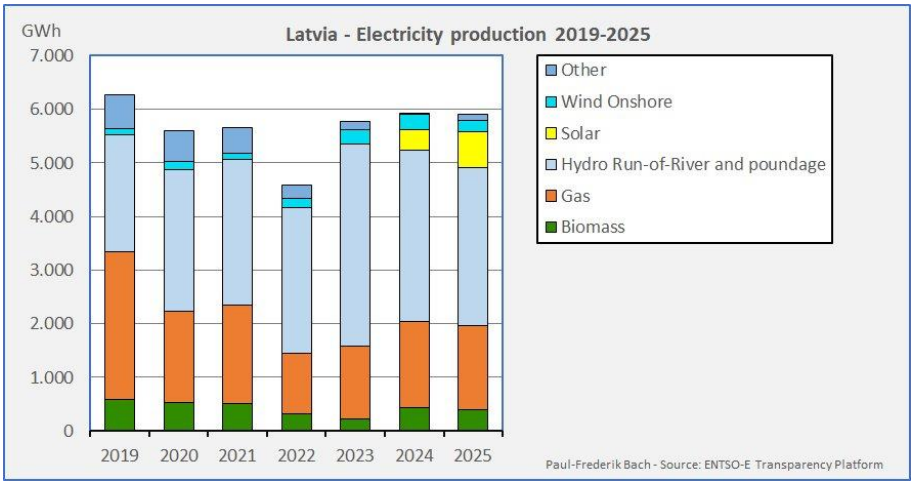
Due to Brexit, it was no longer possible to obtain data for British electricity production from ENTSO-E from 2022, so it was tempting to omit the British data. Great Britain (England, Scotland and Wales) has cables to a number of countries in Scandinavia and on the continent. Therefore, it is interesting for us to know about the British power system. The data for the accompanying graphic has been pieced together from several sources, but hopefully fairly accurate. In 2022, when all countries lacked electricity, the UK was able to mobilize additional gas supplies to export electricity. In 2025, natural gas was still the most important energy source in British electricity production, but wind power supplied almost as much. Solar cells have only achieved a small spread in British electricity production.

Lithuania: Dependent on imports, expanding with wind and solar



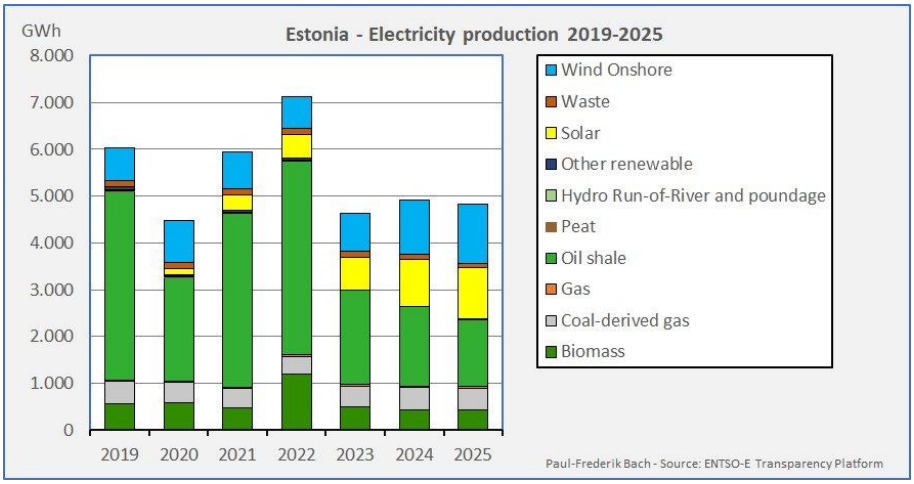
Lithuania has undergone a major transformation, and the result has parallels with Denmark. The three Baltic countries were previously connected to the HVAC grids of Russia and Belarus. There was an HVDC connection from Estonia to Finland and from Lithuania to Poland and Sweden. Lithuania has never been self-sufficient in electricity. The annual electricity consumption is around 12 TWh. In 2019, net imports were 9.5 TWh from Sweden, Belarus, Russia, Latvia and Poland. On 9 February 2025, Lithuania was connected to the Polish HVAC grid, making the three Baltic countries part of the synchronous grid on the European continent. Lithuania's net imports in 2025 were 3.3 TWh from Sweden, Latvia and Poland. Due to the large share of wind and solar energy, the net figures cover large power fluctuations. In 2025, Sweden, Latvia and Poland supplied up to 1500 MW and received up to 1000 MW to ensure the balance of Lithuania's power system.

Latvia: Hydropower from the Daugava River (W. Dvina)



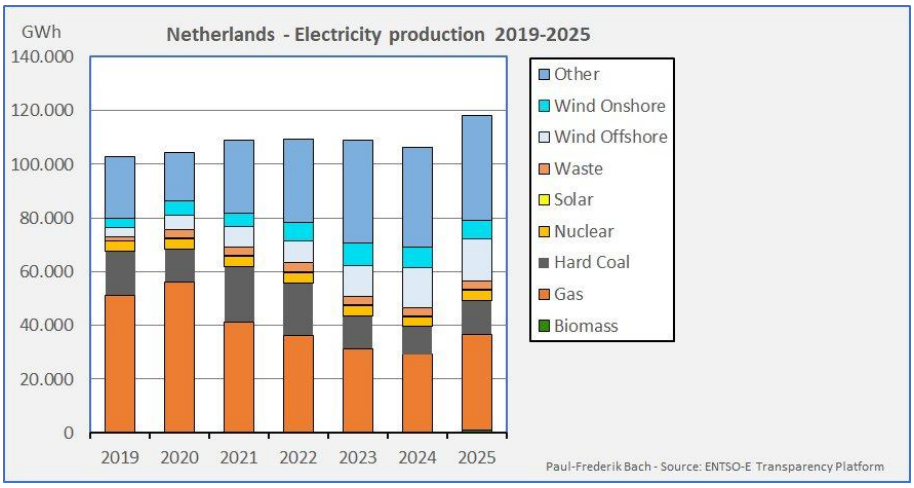
The Daugava River (or Western Dvina) was an important trade route to Russia in the Viking Age and the Middle Ages. In Latvia, there are three dams with hydroelectric power plants, which cover about half of the country's electricity needs. Natural gas was supplied from Russia before 2022, but is now imported as LNG through new infrastructure via Lithuania and Finland. The electricity grid was also connected to the Russian grid, but together with Estonia and Lithuania, this cooperation was interrupted in 2025 in order to become part of the synchronous Western European grid through a new line to Poland. HVDC connections from Finland to Estonia and from Sweden to Lithuania contribute to securing the infrastructure in the three Baltic countries.

Estonia: From oil shale to wind and solar



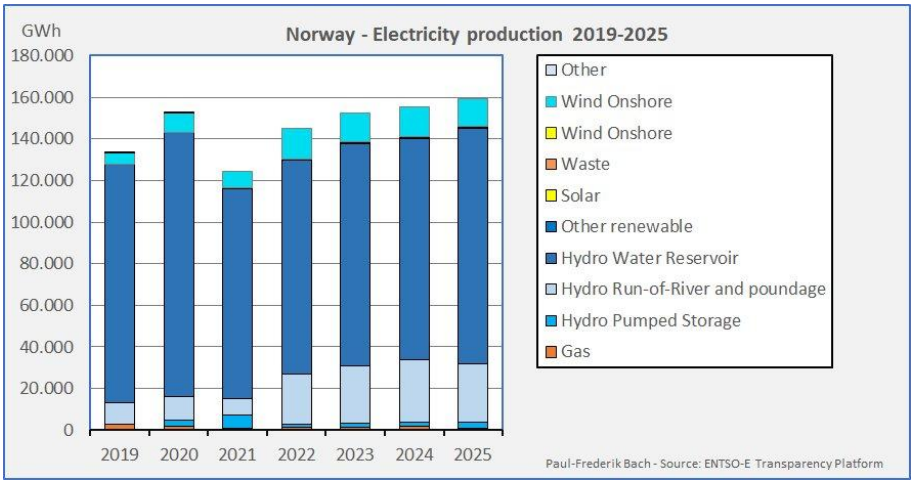
Estonia's electricity consumption is around 8 TWh per year, so Estonia has imported around 3 TWh in each of the years 2023 to 2025. Oil shale has been the most important fuel for electricity production for many years. Finland has been an important supplier through Estlink 1 (HVDC, from 2006, 350MW) and Estlink 2 (HVDC, from 2014, 650 MW). Exchanges with Russia continued until 2023 with imports in 2019 and exports to Russia in the following years. It was possible to increase production from oil shale significantly in the crisis year 2022, after which wind and solar have increasingly contributed. From 2025, Estonia, together with Latvia and Lithuania, has been synchronously connected to the Western European grid.

Netherlands



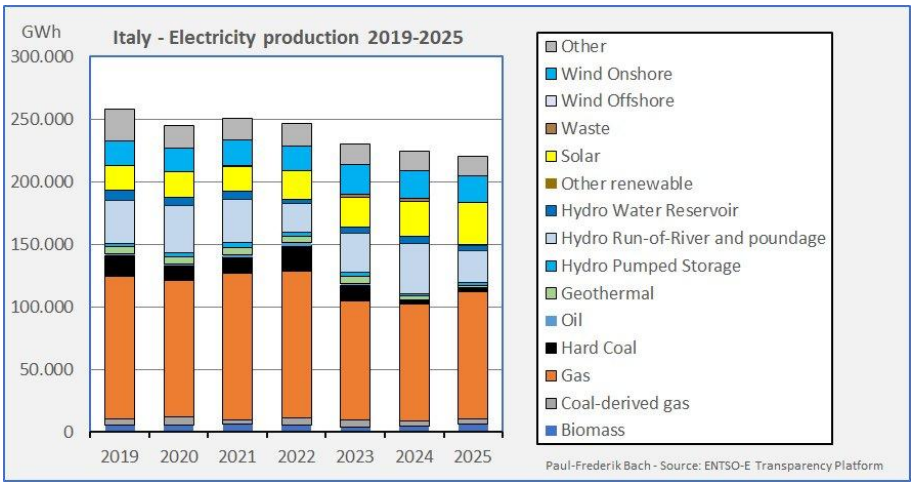
The Netherlands has increased its electricity production, while production has fallen in Belgium. Unfortunately, the Dutch have been sloppy with the figures, so far too much has been included in "Other". From other sources we know that solar cells in 2025 have delivered 20%, while biomass has delivered 5%. The other figures are almost correct. The major growth has been delivered by onshore wind and solar. Natural gas and coal together provided 45%, so the Netherlands still has controllable capacity for balancing, but on the other hand a high proportion of fossil energy.

Norway: Concerns despite abundance of clean energy



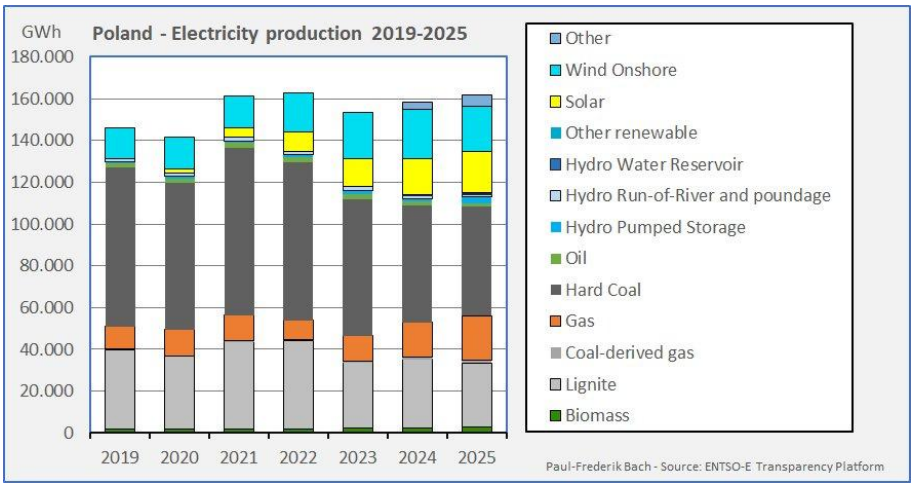
The annual electricity consumption in Norway has fluctuated between 130 and 136 TWh in recent years. That is four times as much as in Denmark. Norway has surplus of electricity 9 years out of 10. With reservoirs of over 80 TWh, one would not think that there could be problems in the Norwegian electricity supply, but that is not how the Norwegians see it at all. They would like to attract even more industry, but hydropower is fully developed, so there is a significant expansion of wind power. Production and consumption have an uneven geographical distribution, and it is difficult to build lines in the mountainous terrain. That is why Norway is divided into 5 price zones. Foreign connections, which are intended to enable the sale of surplus energy, backfire with continental market prices in southern Norway, much to the annoyance of many Norwegians who are used to much lower electricity prices.

Italy: Slow transition



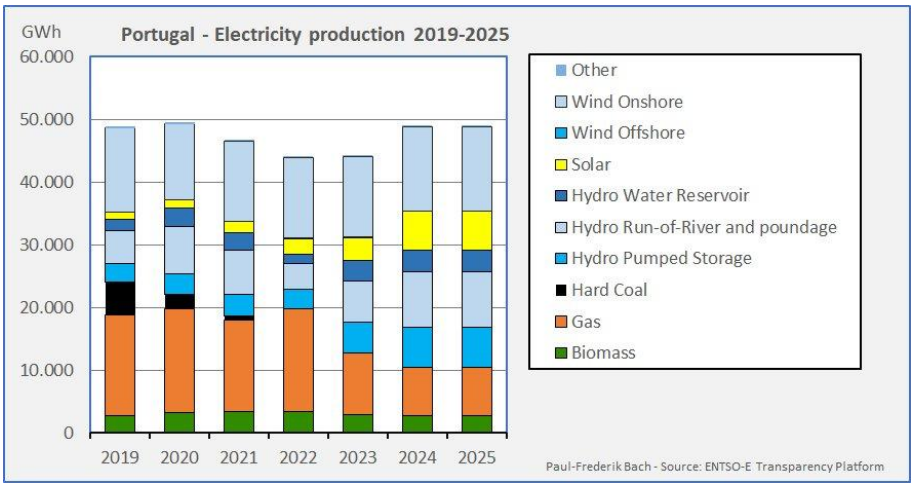
Italy's annual electricity consumption has fluctuated around 280 TWh. The country has not been close to self-sufficiency. In 2025, the share of fossil production was 40%. The most important fuel is natural gas, which covers 37%. Coal has largely been phased out. For Italians, it is obviously about getting electricity where it is cheapest. There is no growth in wind power and only modest growth in solar cells.

Poland: Plan for growth with nuclear power



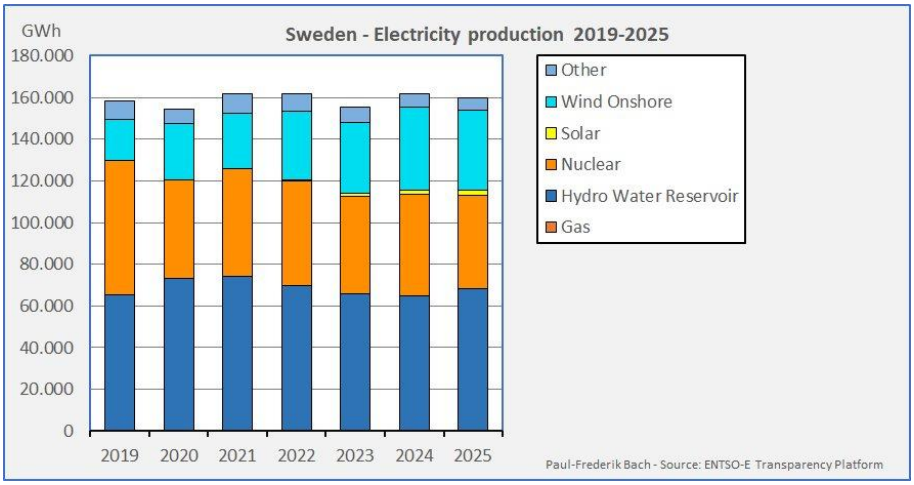
Electricity consumption in Poland has fluctuated between 175 and 158 TWh. The fossil part of production was 75% of consumption in 2019 and 67% in 2025. The share of wind and solar has grown from 9% in 2019 to 26% in 2025. There are signs that Poland expects increased electricity consumption. The Polish government has published the "Polish Nuclear Power Programme". The objective of the programme is described as follows: The objective of the Polish nuclear power programme is to build 6 – 9 GWE of installed nuclear capacity based on large, proven pressurised water reactors.

Portugal:



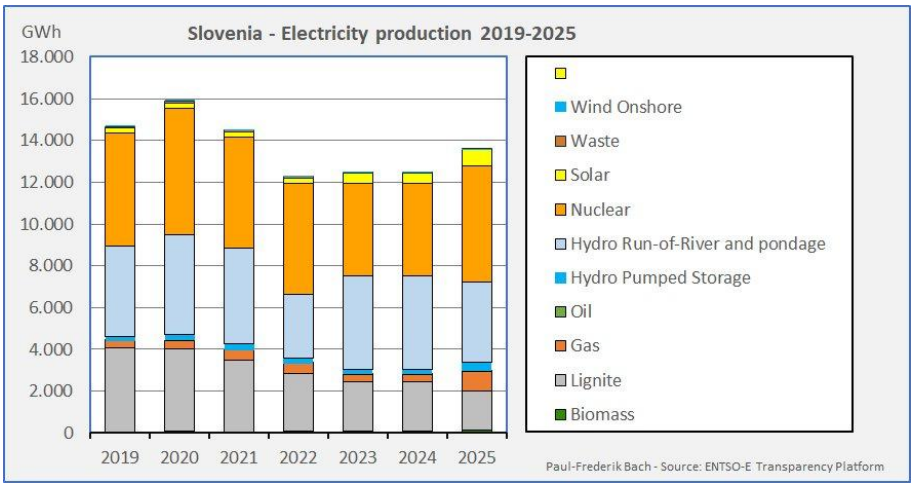
Portugal's electricity consumption is around 50 TWh per year. The production has a diverse range of energy sources. Hydropower covered 36% of consumption in 2025, gas covered 15%, solar cells 12% and biomass 5%. The growth in hydropower is due to the commissioning of the 880 MW Gouvaes hydroelectric power plant in 2022. There has also been growth in solar energy. Coal burning has been phased out. In 2022, there was poor rainfall in Portugal and other European hydroelectric power countries.

Sweden: Preparing for a future with new nuclear power



Sweden's annual electricity consumption has fluctuated between 130 and 140 TWh, so there has been a nice surplus for export every year. Sweden is a country with large distances from north to south. Sweden has a surplus of hydro and wind power in northern Sweden. Nuclear power is located in central Sweden, while southern Sweden lacks production. This results in large transports from north to south in the internal transmission grid. A division into four price zones regulates the transmission of electricity. After looking forward to a gradual closure of the Swedish nuclear power plants, a political agreement from 2022 has decided to change the target from "100% renewable" to "100% fossil-free". This opens up the possibility in practice of building new nuclear power plants and extending the lifespan of existing ones.

Slovenia: Plans for the future of the Krško nuclear power plant



Annual electricity consumption in Slovenia has fluctuated between 10 and 14 TWh. The production consists of 44% nuclear power, 31% hydropower, 15% lignite, 8% natural gas and 6% solar energy, calculated in relation to electricity consumption. The consumption of lignite has been halved since 2019. Nuclear energy is produced at the 696 MWe Krško plant from 1983 in the eastern part of the country. The supplier was Westinghouse. There have been some considerations about expanding the plant with a new unit and about extending the life of the existing unit to 2043.