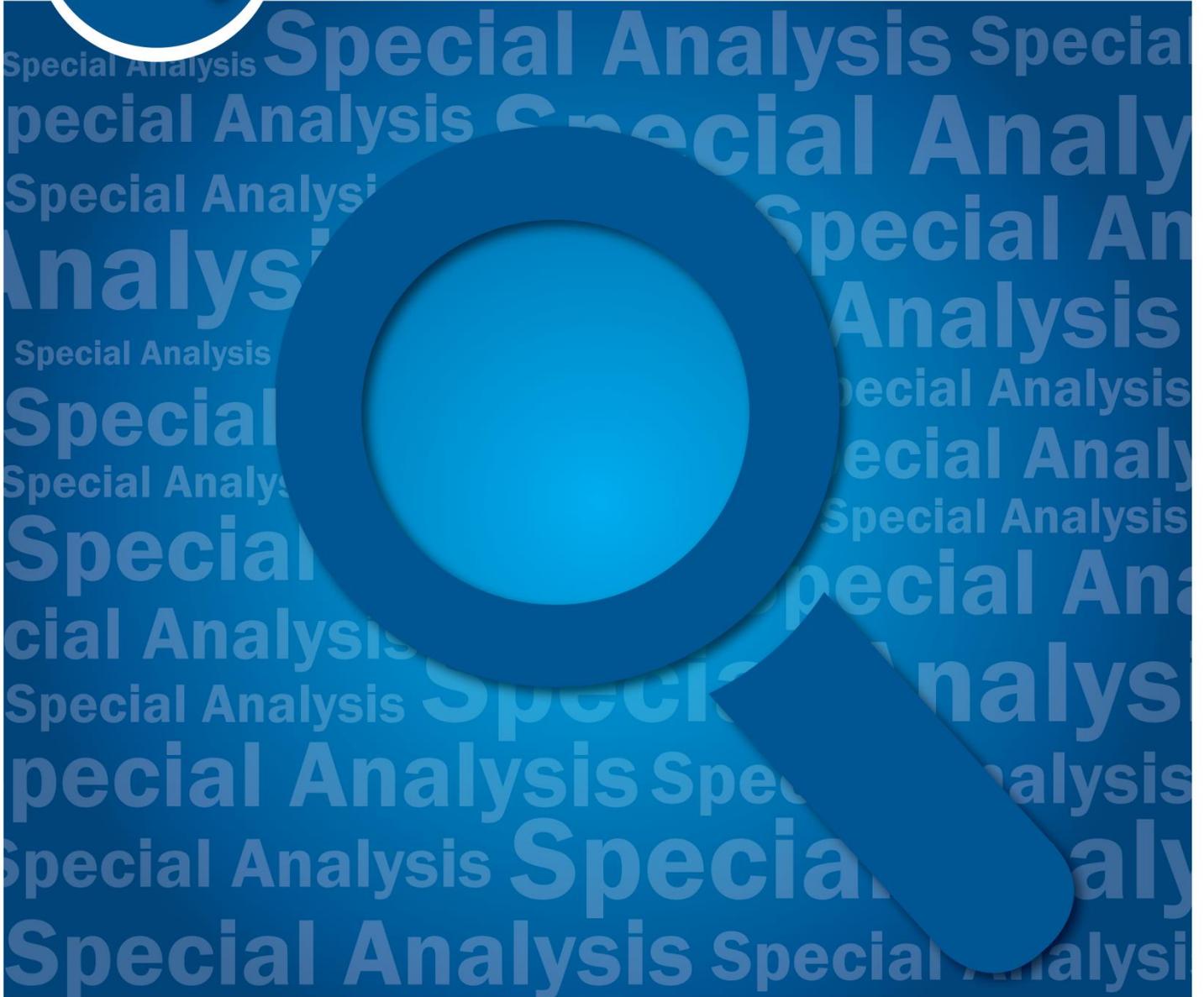




SPECIAL ANALYSIS

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Nuclear Energy In Germany: Development Trends

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Introduction

Six years ago the Federal Republic of Germany decided to embark on the path to a nuclear-free energy economy. In order to understand this concept, which differs significantly from the Czech perception of nuclear energy, it is necessary to look into the history of Germany when the strong resistance formed in one of the strongest anti-nuclear movements in the world.

The massive construction of nuclear power plants in the 70s prompted considerable resentment in what was then West Germany. For a long time the importance of environmental issues grew stronger in the society and it thus became markedly sensitive to the risks associated with producing electricity from nuclear power. Major nuclear accidents at Three Mile Island in the US (1979), Chernobyl in Ukraine (1986) and Fukushima Daiichi in Japan (2011) gradually magnified this trend.

The demand to eliminate the use of nuclear energy for commercial purposes (i.e. Atomausstieg) thus gradually also arrived on the political scene. After long disagreements it was enacted in 2002 during the red-green coalition government (SPD and Die Grünen). The plan, created on the basis of an agreement with energy companies, foresaw a gradual shutdown of nuclear power plants by 2021. After the arrival of the opposition CDU/CSU and FDP to the government this policy was revised. The Christian Democrats and liberals had long taken the role of nuclear energy advocates and had supported its use at least during the period until a suitable alternative was found. In 2010 they pushed through an extension of nuclear power plant operation by an average of 12 years. The last nuclear power plant would therefore be disconnected roughly in the year 2040.

Three months after the decision to extend the lifetime of nuclear power plants, the nuclear accident in Japan at Fukushima Daiichi happened. The German government responded to this event with a radical change in its existing energy policy. The coalition parties CDU/CSU and FDP pushed through an accelerated withdrawal from the use of nuclear energy by 2022, which abolished the previous decision on extending the lifetime of nuclear power plants. This time a broad consensus prevailed on the political scene concerning the future use of nuclear energy. All parties in the German Bundestag supported abandoning it as soon as possible.

Unlike the first "Atomausstieg" advocated by the red-green government, this decision is thus characterized by higher legitimacy. Nationwide support for "Atomausstieg" is still very high even six years after its enactment. Due to the same trend on the political scene as well, it is highly unlikely that any party in the future would completely reverse this course.

Recent Developments and Statistics

Until March 2011 when the previously mentioned political reversal happened in Germany, nuclear energy covered ¼ of electricity production in the country. This production was provided by 17 reactors. In response to the Fukushima accident, under the government moratorium eight of the oldest reactors which were already offline for a safety review were immediately shut down. Today nuclear power plants generate 13% of the electricity in the country, which represents nearly half the value compared to 2011.

The consequence of these shutdowns was that Germany had to deal with the loss of energy which had to be replaced from other sources. These were mainly solid fuels and natural gas. Consequently, there was a short-term increase in electricity production from coal and lignite. During this time these values peaked in 2013 when they reached 45% of total electricity production. In the next two years levels again declined roughly to the original level.

Decommissioning of individual nuclear reactors

Reactor	Date	Reaktor	Date
Obrigheim	2002	Krümmel	6. 8. 2011
Stade	2004	Gundremmingen B	31. 12. 2017
Biblis A	6. 8. 2011	Grohnde	31. 12. 2021
Biblis B	6. 8. 2011	Gundremmingen C	31. 12. 2021
Neckarwestheim	6. 8. 2011	Philippsburg 2	31. 12. 2019
Brunsbüttel	6. 8. 2011	Brokdorf	31. 12. 2021
Isar 1	6. 8. 2011	Isar 2	31. 12. 2022
Unterweser	6. 8. 2011	Emsland	31. 12. 2022
Philippsburg 1	6. 8. 2011	Neckarwestheim 2	31. 12. 2022
Grafenrheinfeld	31. 12. 2015		

Source: Dreizehntes Gesetz zur Änderung des Atomgesetzes

Furthermore there was also an increase in electricity production from natural gas. This was only a short-term fluctuation however, as in the long term it did not rise. Shortly after the government moratorium imports of electricity from abroad increased.

These were mainly imports from the Czech Republic and France. The imports were mainly channeled into southern federal states which until then had been strongly supplied with electricity from nuclear power.

This fact reflects an altogether paradoxical situation since a significant proportion of electricity in the Czech Republic and France is produced from nuclear power. From a long-term perspective however, Germany is a net exporter of electricity. On the other hand Germany is one of the world's largest importers of natural gas, oil and coal. It has only very limited domestic resources in the form of brown coal and renewable resources.

Renewable energy sources (RES) also contributed to offsetting the deficit in the supply of electricity since between 2010 and 2013 they increased significantly from 16.5% to 23.7%.

Energy mix

In Germany's current energy mix (figures for 2016) the trend continues where solid fuel still accounts for most electricity production. In Germany 40% of electricity is now produced from lignite and hard coal.

The predominance of coal in the energy mix and the size of the economy put Germany in the position of Europe's largest emitter of greenhouse gases. The second largest source of energy is renewable energy sources which amount to 30% in Germany.

Of these, the most widespread are wind turbines followed by biomass. The increase in renewable energy sources in 2016 was the lowest since 2009.

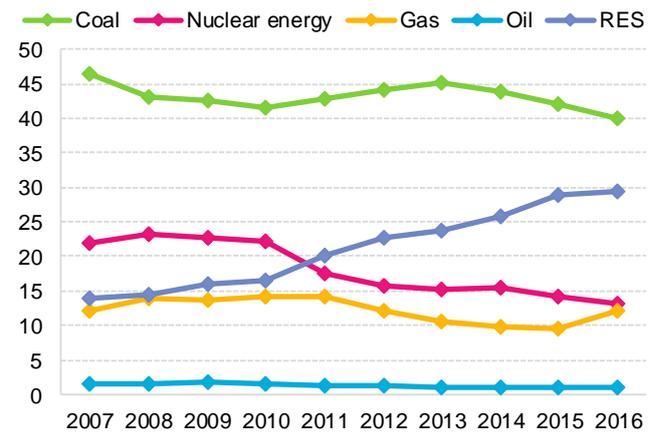
The share of other sources varies, in the case of natural gas around 12% and nuclear around 13%. The difference in the representation of nuclear energy in comparison with the Czech energy mix is precisely what is most striking. The Czech Republic has more than double the share of nuclear energy in electricity production.

Energiewende

The shift away from the use of nuclear power is part of the overall transformation of the German energy economy called "Energiewende". This is a transition to a sustainable energy supply and a move away from use of fossil fuels and nuclear energy towards use of renewable sources of energy. The main objectives of Energiewende are to reduce greenhouse gas emissions and dependence on fossil fuel imports. These objectives are to be achieved by developing renewable sources of energy, improving energy efficiency and increasing energy savings. It is interesting that Germany envisages that its own supply of renewable energy sources will almost be the largest part of the energy mix by 2050.

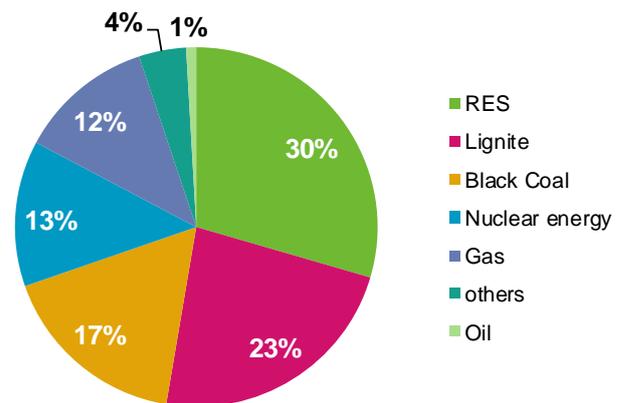
Doubts have emerged about whether the country will be able to meet its commitments concerning greenhouse gas emissions. This is within the situation of phasing out relatively low emission nuclear power and the still relatively high proportion of coal resources, which has even increased in recent years.

Gross electricity production in Germany (%)



Source: AGEB

Energy Mix (2016)



Source: Bundesministerium für Wirtschaft und Energie

Basic goals of EW

	2020	2030	2040	2050
Greenhouse gas emissions (compared with 1990)	-40%	- 55%	- 70%	- 80 - 95%
Primary energy consumption (compared with 2008)	- 20%	-	-	- 50%
Demand for electricity (compared with 2008)	- 10%	-	-	- 25%
Heat consumption in the residential sector	- 20%	-	-	-
Share of RES (renewable energy sources) in electricity consumption	More than 35%	More than 50%	More than 65%	More than 80%
Share of RES in final energy consumption	18%	30%	45%	60%

Source: Agora Energiewende

Current Issues

Due to the significant transformation of the energy system, Germany must deal with the many challenges that accompany this conversion process.

Primarily these are challenges associated with the integration of renewable sources into the energy system. As is known, these sources are highly unstable and energy supply is therefore dependent on external conditions (sunlight, wind strength, etc.).

The transmission system must thus cope with many unforeseen inflows of electricity which fluctuate throughout the days and seasons.

As a consequence Germany must often contend with transmission system overloads and short-term surpluses of produced energy. This surplus is sometimes even offered in the energy market at a negative price to ensure its sales.

Because of the mentioned instability of renewable sources, growth in the significance of flexible resources such as natural gas can be expected in the future since they could fill the gaps in the production from renewable sources relatively well.

A negative factor is that Germany is 90% dependent on imports of this resource, with the largest share imported from Russia. The ultimate consequence of this could be further deepening of energy dependence on major suppliers of energy resources.

Another problem that Germany is forced to address is insufficient north-south interconnection of the transmission system. In Germany there is a geographic imbalance regarding energy production. In the north huge wind farms that generate large amounts of electricity can be found.

Conversely, the south of the country has traditionally been supplied from the production of nuclear power plants which are gradually being shut down. Thus in the north there is often overproduction which must be transported to the southern federal states, where demand outstrips supply.

However since Germany does not have sufficient connections electricity is transported through neighboring countries, usually via Poland and the Czech Republic, and back to Bavaria and Baden-Württemberg.



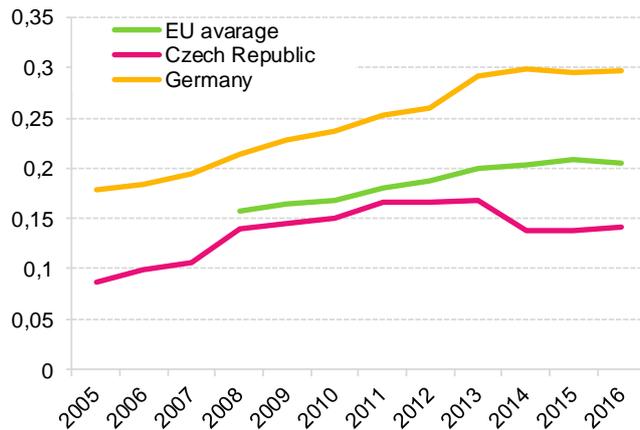
Electricity prices

In Germany in recent years there have been price increases in electricity for households. Since 2005 the price of electricity for medium-sized households increased by almost 100%, from 0.178 to 0.297 EUR per kWh in 2016. This is therefore a noticeable increase in household expenditures on energy consumption.

In contrast, the price of electricity for midsize businesses recorded mainly a downward trend since 2012 and is currently at the level of 0.079 EUR per kWh.

From this fact we can see that it is predominantly households that carry the costs of the so-called Energiewende. Germans thus have the second most expensive electricity in the European Union.

Electricity prices for households (EUR/kWh)



Source: Eurostat, medium size households

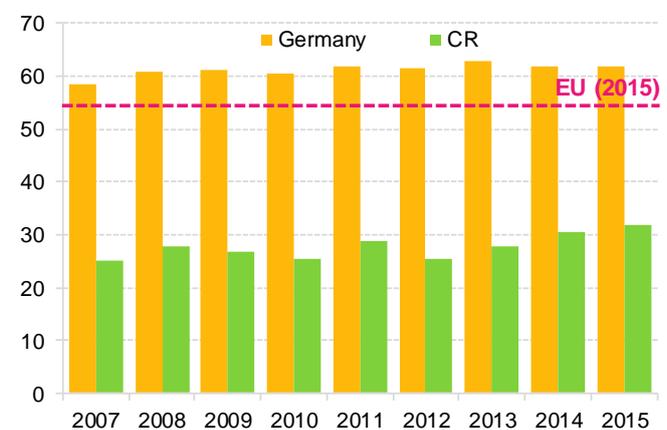
Development of energy dependency

Energy dependency or dependence of the economy on imports of energy resources is still high in Germany. In 2015 it reached 61.5%, which represents almost twice the amount in the Czech Republic.

This is due to the fact that the Czech Republic has a high proportion of nuclear energy, which is considered as a domestic source, and moreover it has its own reserves of lignite and black coal. German energy resources in this respect are rather limited.

In recent years German energy dependency increased slightly and this was precisely from 2011 when the eight nuclear power plants were disconnected from the network and energy imports into the country rose.

Energy dependence - Germany and CR (%)



Source: Eurostat

Developments in the EU

In the European context Germany is a leader in withdrawal from the use of nuclear energy and thus the transition to a non-nuclear economic model. It therefore belongs among the few advanced industrialized economies which have opted for a radical transformation of their energy supply.

In the field of European policy uniform consensus on nuclear policy does not exist and access in each country to nuclear power varies considerably. Despite efforts to deepen integration in the area of EU energy policy, decisions on the form of the energy mix remain with national governments. It is highly unlikely that governments will surrender this power in the future.

An example of a strongly pro-nuclear country is France on whose territory 58 reactors are situated, which represent more than 1/3 of the power plants in the whole European Union. France is therefore the country that uses the most nuclear energy in the whole union. In this way it covers about 75% of electricity production. The remainder of electricity production is derived from hydro and gas power plants. For this reason the French energy economy is thus very low-emission and as a CO2 emitter it lies far below the EU average.

In a diametrically opposed position is Poland, which is among the largest emitters of greenhouse gases in the EU. Over 90% of electricity in Poland is obtained by burning coal and lignite. The country is thus heavily dependent on coal supply. So far Poland does not have any nuclear power plants, but due to reductions in emissions it is planning to build them.

Italy is the only one of the eight global industrial powers known as the G8 which does not use nuclear energy. However, the country is dependent on imports of electricity from abroad and these are mainly from French nuclear power plants, which spoils the image of Italy as a nuclear-free economy. Another European country that has never produced nuclear energy is Austria. There in the end of the 70s the nuclear power plant Zwentendorf was built, but the start of its operation was rejected in a local referendum.

Great Britain is committed to significantly reducing CO2 emissions. Its energy mix includes nuclear, renewable sources and fossil fuels. In the future it plans to replace obsolete nuclear power plants with new ones.

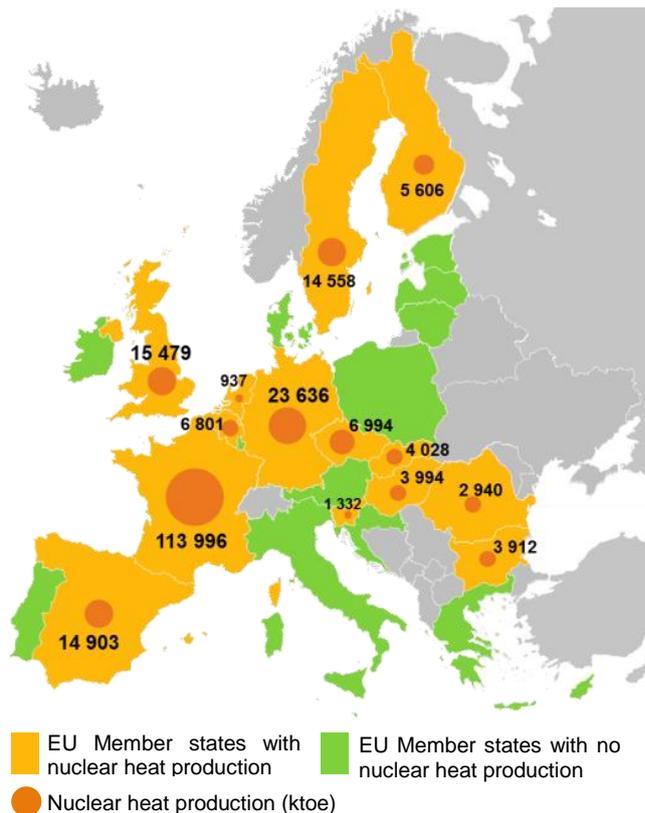
In the Czech Republic nuclear energy is produced by two nuclear power plants, Temelin and Dukovany (a total of six reactors) and they produce about one third of all electricity in the country. Although nuclear energy has long been supported by the government and the state energy policy envisages its expansion, thanks to low electricity prices and absence of government guarantees the addition of nuclear units in the Czech Republic is highly uncertain.

The examples mentioned show how diverse national strategies are in the 28 EU countries. In half of them nuclear power plants can be found and in the other half of the countries nuclear power is not yet used.

Poland and Lithuania want this to change in the foreseeable future however, and are beginning the construction of nuclear power plants.

Conversely Germany and Belgium want to discontinue commercial use of nuclear energy in the near future.

Performance of nuclear power plants in the EU



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