GERMANY 2011

(Updated 2012)

1. General Information

1.1. Country overview

1.1.1. Governmental system

Germany is a parliamentary federal republic consisting of 16 states or *Länder*. The German constitution (Basic Law – *Grundgesetz*) guarantees separation of powers.

The German *Bundestag* (Federal Parliament) and the *Bundesrat* (Federal Council) form the German legislative branch. The members of the *Bundestag* are elected by popular vote based on proportional representation. The members of the *Bundesrat* are representatives of the governments of the 16 states (*Landesregierungen*).

The Federal President (*Bundespräsident*) is head of state and elected by the Federal Assembly (*Bundesversammlung*), consisting of the members of the *Bundestag* and representatives chosen by the state parliaments.

The Federal Chancellor (*Bundeskanzler*) is the head of the Federal Government and elected by the *Bundestag*. The Chancellor, together with the Federal Ministers, is responsible for the conduct of Federal Government business.

The Federal Constitutional Court (*Bundesverfassungsgericht*) is the German Supreme Court.

1.1.2. Geography and climate

Germany is situated in central Europe and has nine neighbouring countries, Denmark, Poland, the Czech Republic, Austria, Switzerland, France, Luxembourg, Belgium and the Netherlands, and borders on the North Sea and the Baltic Sea.

Germany has a temperate climate with an average annual temperature of +8.3°C. The average annual precipitation is 770 mm.

1.1.3. Population

See Table 1.

The current population of Germany has decreased from a peak of 82.5 million inhabitants in 2002. According to the estimations of the Federal Statistical Office (*Statistisches Bundesamt),* this trend will continue due to steadily decreasing birth rates. It is expected that in the year 2060 the population will be about 65 to 70 million.

TABLE 1: POPULATION INFORMATION

						Average annual growth rate (%)
1970[1)]	**1980[1)]**	**1991**	**2000**	**2005**	**2010**	**2000 to**

							2010
Population (millions)	61.0 (17.1)	61.7 (16.7)	80.3	82.3	82.4	81.8	- 0.06
Population density (inhabitants/km²)	245 (158)	248 (155)	225	230	231	229	
Urban population (% of total)				87.5	88.5		
Area (1000 km²)						357,0	

1) Numbers refer to the Federal Republic of Germany (FRG, West Germany) before reunification in 1990; numbers in brackets refer to the former German Democratic Republic (GDR, East Germany).
Source: Country Information [1].

1.1.4. Economic data

See Table 2

TABLE 2: GROSS DOMESTIC PRODUCT (GDP)

	1970[1]	1980[1]	1991	2000	2005	2010[4]	Average annual growth rate (%) 2000 to 2010
GDP (current prices, billion €)	360,600 (–)	788,520 (–)	1,534.600	2,047.500	2,242.400	2,476.800	+ 2.1
GDP (current prices, billion US$)	193,406 (40,063)	849,288 (134,301)	1,815.061	1,891.934	2,771.057	3,286.451	+ 7.4[5]
GDP (constant prices, billion €)[2]			1,878.895	2,159.781	2,220.952	2,364.092	+ 0.9
GDP per capita (current prices, €)			19,204	24,947	27,014	30,352	+ 2.2
GDP per capita (current prices, US$)			22,713	23,051	33,653	40,274	+ 7.5[5]
GDP per capita (based on PPP[3],US$)			19,686	26,126	30,266	36,081	+ 3.8

1) Numbers refer to the Federal Republic of Germany (FRG, West Germany) before reunification in 1990; numbers in brackets refer to the former German Democratic Republic (GDR, East Germany).
2) Base year 2005
3) PPP: Purchasing Power Parity
4) preliminary data
5) affected by the exchange rate from Euro to US Dollar
Source: Country Information [1] and IMF-International Monetary Fund.

1.2. Energy information

1.2.1. Estimated available energy

See Table 3

TABLE 3: ESTIMATED AVAILABLE ENERGY SOURCES IN 2010

	Estimated available energy sources 2010					
	Fossil Fuels			Nuclear	Renewables	
	Solid[2]	**Liquid**[2]	**Gas**[2]	**Uranium**	**Hydro**	**Other renewable**
Total amount in	160,021	61	973	0.007		

specific units [1]						
Total amount in Exajoule (EJ)	2,898	2.549	36.974	3.5	0.4[3]	n.d.[4]

[1] Solid, Liquid: Million tons, Gas: Billion m^3; Uranium: Million metric tons, Hydro, Renewables: TW

[2] remaining potential including reserves (proven volumes of energy resources economically exploitable at today's prices and using today's technology) and resources (proven amounts of energy resources which cannot currently be exploited for technical and/or economic reasons, as well as unproven but geologically possible energy resources which may be exploitable in future).

[3] gross theoretical capability per year; about 0.09 EJ/a corresponds to the technically exploitable capability.

[4] n.d.: not determined

Source: Country Information [2] and World Energy Council.

1.2.2. Energy statistics

See Table 4

TABLE 4: ENERGY STATISTICS (EJ)

	1970[1) 6)]	1980[1)]	1991	2000	2005	2010[7)]	Average annual growth rate (%) 2000 to 2010
Energy consumption[2)]							
- Total	9.87 (3.06)	11.35 (3.54)	14.61	14.40	14.54	14.04	- 0.03
- Solids[3)]	3.73 (2.60)	3.41 (2.48)	4.84	3.57	3.40	3.23	- 0.1
- Liquids	5.24 (0.41)	5.44 (0.62)	5.53	5.50	5.17	4.68	- 1.5
- Gases	0.53 (0.02)	1.86 (0.30)	2.41	2.99	3.23	3.08	+ 0.3
- Nuclear	0.06 (0.01)	0.48 (0.13)	1.61	1.85	1.78	1.53	- 1.7
- Hydro + Wind[4)]	0.25 (0.01)	0.06 (0.00)	0.05	0.13	0.17	0.25	+ 9.2
- Others[5)]	0.06 (0.01)	0.10 (0.01)	0.18	0.36	0.79	1.28	+ 25.6
Energy production							
- Total	5.15 (2.43)	5.11 (2.55)	6.97	5.94	5.89	5.56	- 1.0
- Solids[3)]	4.13 (2.37)	3.70 (2.30)	4.44	2.54	2.37	1.92	- 2.6
- Liquids	0.32 (0.01)	0.20 (0.00)	0.15	0.13	0.15	0.11	- 0.9
- Gases	0.41 (0.02)	0.59 (0.11)	0.57	0.65	0.60	0.41	- 3.3
- Nuclear	0.06 (0.01)	0.48 (0.13)	1.61	1.85	1.78	1.53	- 2.3
- Hydro	0.17 (0.01)	0.06 (0.00)	0.05	0.09	0.07	0.07	- 2.5
- Wind	–	–	0.00	0.03	0.10	0.13	+ 40.7
- Others[5)]	0.06 (0.01)	0.10 (0.01)	0.15	0.35	0.81	1.34	+ 26.3
Net import (Import – Export)							
- Total	4.72 (0.63)	6.24 (0.99)	7.64	8.46	8.65	8.48	- 0.6

[1)] Numbers refer to the Federal Republic of Germany (FRG, West Germany) before reunification in 1990; numbers in brackets refer to the former German Democratic Republic (GDR, East Germany).

[2)] Energy consumption = Primary energy production + Net import (Import-Export) of secondary energy

[3)] Solid fuels include coal and lignite

[4)] Wind power since 1995, including solar

[5)] Others are e.g. firewood, bio solids, waste, geothermal, etc.

[6)] Data from 1970 according to substitution method, later data according to efficiency method

[7)] preliminary data

Source: Country Information [3] [4].

1.2.3. Energy policy

Energy policy is, within the Federal Government, the responsibility of the Federal Ministry of Economics and Technology (*Bundesministerium für Wirtschaft und Technologie - BMWi*). The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit – BMU*) is responsible for environmental policy within the Federal Government. Among others, the goals of the BMU are radiological protection as well as intelligent and economical handling of resources and energy.

The major aims of energy policy are economic efficiency, security of supply and environmental compatibility. As Germany is poor in natural raw materials, the country is particularly reliant on imports. To secure the supplies, the use of a broad mix of energy suppliers and of different sources from around the world is favoured. In addition, it is intended to reduce energy needs by more economical and rational use.

In 2000, the Federal Government and the energy utilities agreed to phase out nuclear energy use for commercial power generation, and the Atomic Energy Act was amended accordingly in 2002. A legal ban on the construction of new nuclear power plants was fixed. Each nuclear power plant was assigned a residual electricity volume such that the total output of the respective plant corresponds to an average 32-year lifetime. As electricity volumes can, in principle, be legally transferred between plants, it was not possible to forecast precise shut-down dates. In 2011, in the light of the accident at the Japanese Fukushima Daiichi NPP, final shutdown dates for all operating German NPPs have been fixed (for more details see chapter 2.1.1).

In 2010, the Government adopted its energy concept. Step by step, 60% of the energy supply and even 80% of electricity should be generated by renewables by 2050. Apart from expanding and strengthening the renewables, it is planned to expand the transmission net, to build new energy storages and to reduce the need for primary energy. To reach this aim, the Government established additional funds in the framework of the energy concept (Energy and Climate Funds) in 2011, which will increase to up to 2.5 billion Euros in the medium term and will be used, among others, for research in renewables energies, energy efficiency, technologies for energy storage and transmission as well as national climate protection.

1.3. The electricity system

1.3.1. Electricity policy and decision making process

German electricity policy is based on three fundamental objectives: sustainability, security of supply and economic efficiency. The main challenge will be the integration of an increasing number of plants generating electricity from renewable sources, including a large amount of offshore wind farms in the Baltic and North Sea. Consequently, the German electricity grid and the electricity market are facing new challenges.

Since 1998, Germany has been continuing the process of liberalising its electricity market. Currently, all customers are free to choose their own suppliers.

The Energy Industry Act (*Energiewirtschaftsgesetz*), together with secondary legislation enacted under it, specifies a new regulatory framework governing grid access and transmission fees for electricity and gas. The objective is to provide the public with a secure, affordable, consumer-friendly, efficient and environmentally compatible supply of grid electricity and gas. Enforcement lies with the Federal Network Agency (*Bundesnetzagentur*), which regulates electricity, gas, telecommunications, postal and railway networks spanning two or more federal states and network operators with more than 100,000 customers. Network operators with fewer than 100,000 customers are regulated by regulatory agencies in the individual German federal states. The main features of the new legal framework relate to network access and transit fees, and separating network operation from companies' other activities. The network regulator, a public agency under the Federal Ministry of Economics and Technology, has a clear legal mandate to keep down transit fees while assuring security of supply. Grid operators are required to operate a secure, reliable, high-capacity energy supply network, to maintain this network and to expand it in line with demand.

1.3.2. Structure of electric power sector

- Generation

Four large companies dominate the electricity generation market in Germany (*E.ON*, *RWE*, *EnBW* and *Vattenfall*). All together, these companies generated more than 85% of electricity in Germany in the year 2005. The remainder came from independent generators, industry self-generators selling back to the grid and from the industry producing for its own use.

Though demand for electricity is forecast to remain relatively flat, construction projects for power plants using both conventional fuels and renewables are currently in the planning, preparation or building phase in order to replace existing plants, particularly nuclear plants, slated for closure.

- Transmission

Germany's transmission grid is well interconnected and made of about 35,000 km of extra-high-voltage (220 or 380 kilovolt), 77,000 km of high-voltage (> 60 to < 220 kilovolt), 479,000 km of medium-voltage (6 to 60 kilovolt) and 1,123,000 km of low-voltage (230 or 700 volt) transmission lines. In the past, the four companies dominating electricity generation each owned their own transmission companies operating the extra-high-voltage transmission lines. Now, the transmission companies are legally unbundled companies (*TenneT TSO GmbH*, *Amprion GmbH*, *TransnetBW GmbH* and *50Hertz Transmission GmbH*). They provide non-discriminatory third-party access to their networks for all generators. All decisions on grid access and access fees can be appealed to the Federal Network Agency (*Bundesnetzagentur*) or to the respective regional regulator (*Länderregulierungsbehörde*). Grid fees, which cover transmission operations and investments, are charged to distributor companies, which pass them on to the end-use customers via retail rates. Transmission system operators charge distribution companies via a "postage stamp" rate, at a single flat rate per kW of maximum demand.

Under the Renewable Energy Sources Act (*Erneuerbare-Energien-Gesetz – EEG*), grid system operators are required to connect plants generating electricity from renewable sources to their system at standard rates and to guarantee priority feed-in and transmission of electricity to such plants.

The extension of renewables, intensified transboundary power trading and new conventional power plants are the main reasons for the plans to modernize the existing transmission grid and to build up new extra-high-voltage transmission lines.

Germany's grid is linked to its neighbours' power grids via cross-border connections. The interconnection capacity is equivalent to about 15% of total capacity.

The transmission lines for lower voltages are used to distribute electricity to the customers. In this part, various regional and municipal transmission companies are involved.

- Distribution

There are about 900 distribution system operators in Germany. There is significant cross-ownership of distribution and retail in Germany's electricity sector through the country's many regional and local utilities, or *Stadtwerke*. The electricity generating companies, *E.ON*, *RWE*, *EnBW* and *Vattenfall*, have stakes in a large percentage of *Stadtwerke*, but the National Competition Authority (*Bundeskartellamt*) has become more and more restrictive in its approval of such mergers.

1.3.3. Main indicators

See Table 5 and Table 6

The capacity of electrical plants and the electricity production as shown in Table 5 are reported as gross values.

Hard coal, lignite and nuclear power plants typically run with a maximum number of operating hours. They provide 65% of the total electricity consumption. Gas power and pump-storage facilities are used additionally.

For further information regarding the electricity system see [7].

TABLE 5: ELECTRICITY PRODUCTION, CONSUMPTION AND CAPACITY

	1970[1)]	1980[1)]	1991	2000	2005	2010[4)]	Average annual growth rate (%) 2000 to 2010
Capacity of electrical plants (GWe)							
- Thermal[2)]	42.0 (11.3)	67.5 (16.5)	92.2	83.9	77.5	82.6	- 0.2
- Nuclear	0.9 (0.1)	8.7 (1.7)	23.7	23.6	21.4	21.5	- 0.9
- Hydro[3)]	4.7 (0.7)	6.5 (1.5)	8.7	9.0	10.2	10.4	+1.6
- Wind	0.0 (0.0)	0.0 (0.0)	0.1	6.1	18.4	27.2	+ 34.6
- Photovoltaics	–	–	0.002	0.076	2.1	17.3	+2266
- Others	–	–	1.4	2.7	7.0	11.1	+ 31.1
- Total	47.6 (12.1)	82.7 (19.7)	126.1	125.3	136.5	170.1	+ 3.6
Electricity production (TWh)							
- Thermal[2)]	218.8 (65.9)	306.4 (85.3)	359.2	346.5	370.8	358.1	+ 0.3
- Nuclear	2.7 (0.5)	41.4 (11.9)	147.4	169.6	163.0	140.6	+ 1.7
- Hydro	16.2 (1.3)	17.4 (1.7)	19.2	29.4	26.7	27.4	- 0.7
- Wind	0.0	0.0	0.1	9.5	27.2	37.8	+ 29.8
- Photovoltaics	–	–	–	0	1.3	11.7	+ 117
- Others	–	–	14.3	21.5	31.6	52.7	+ 14.5
- Total	237.7 (67.7)	365.2 (98.9)	540.2	576.5	620.6	628.1	+ 0.9
Electricity consumption (TWh)							
- Total			539.6	579.6	612.1	610.4	+ 0.5

1) Numbers refer to the Federal Republic of Germany (FRG, West Germany) before reunification in 1990; numbers in brackets refer to the former German Democratic Republic (GDR, East Germany).
2) Thermal includes hard coal, lignite, gas and oil, pump-storage facilities and other.
3) Water mills and storage plants
4) preliminary data
Source: Country Information [3] [4] and BDEW-*Bund der Energie- und Wasserwirtschaft*.

TABLE 6: ENERGY RELATED RATIOS

	1970[1)]	1980[1)]	1991	2000	2005	2010
Energy consumption per capita (GJ/capita)	162 (179)	184 (212)	183	175	176	172
Electricity consumption per capita (kWh/capita)			6720	7043	7428	7462
Electricity production/Energy production (%)	17 (10)	26 (14)	28	35	38	41
Nuclear/Total electricity (%)	1.1 (0.7)	11.3 (12.0)	27.3	29.5	26.3	22.4
Ratio of external dependency[2)] (%)	48 (21)	55 (28)	51	59	60	60

1) Numbers refer to the Federal Republic of Germany (FRG, West Germany) before reunification in 1990; numbers in brackets refer to the former German Democratic Republic (GDR, East Germany).
2) Net import / Total energy consumption
Source: Country Information.

2. NUCLEAR POWER SITUATION

2.1. Historical development and current organizational structure

2.1.1. Overview

In 1955, the Federal Republic of Germany, i.e. the western part of the then-divided Germany (West Germany), officially renounced the production, possession or use of nuclear weapons. Research and development of nuclear energy for peaceful purposes began. Based on extensive international co-operation, several prototype reactors were constructed and concepts for a closed nuclear fuel cycle and for the final storage of radioactive waste in deep geological formations were elaborated.

From 1956 to 1969 several nuclear research centres were founded in West Germany. Most of these research centres as well as university institutes were equipped with research reactors.

With the assistance of US manufacturers, West Germany started to develop commercial nuclear power plants (Siemens/Westinghouse for pressurized water reactors - PWR, General Electric/AEG for boiling water reactors - BWR). In 1958, the first West German nuclear power plant (NPP) - a 16 MWe experimental nuclear power plant (*Versuchsatomkraftwerk Kahl*, VAK) - was ordered from General Electric/AEG and reached criticality in 1960. Domestic West German nuclear development began in 1961, with the order of the 15 MWe pebble-bed high-temperature reactor (*Arbeitsgemeinschaft Versuchsreaktor* at Jülich, AVR) from the *Arbeitsgemeinschaft BBC /Krupp* (BBC - Brown, Boverie & Cie., meanwhile ABB Asea Brown Boveri Ltd.). Power reactors with 250-350 MWe and 600-700 MWe were ordered between 1965 and 1970.

After about 15 years, the gap between the West German and the international technological state of the art was closed. The West German nuclear industry received the first orders from abroad, from the Netherlands (Borssele) and from Argentina (Atucha). In 1972, the construction of the world's then largest reactor, Biblis A with 1200 MWe, started in West Germany. Between 1970 and 1975, an average of three units was ordered annually.

In 1969, Siemens and AEG founded *Kraftwerk Union* (KWU) by merging their respective nuclear activities. The domestic development of KWU nuclear power plants with PWRs started. Based on several years of operational experience, a standardized 1300 MWe PWR (the so-called "Konvoi") was introduced, mainly to speed up the licensing process. Three "Konvoi"-units started to operate in 1988 and were the last NPPs built in West Germany.

The German Democratic Republic, i.e. the eastern part of the then-divided Germany (East Germany), started to develop a nuclear programme for the peaceful use of nuclear energy with the assistance of the Soviet Union, in 1955. In 1956, the Central Institute for Nuclear Physics was founded at Rossendorf. There, in 1957, a research reactor supplied by the Soviet Union started operation. The first East German 70 MWe nuclear power plant Rheinsberg, equipped with a Russian type PWR, was connected to the grid in 1966. Between 1974 and 1979, the Greifswald NPP units 1 to 4 started operation, all equipped with Russian WWER-440/W-230 reactors. In 1989, unit 5, a WWER-440/W-213 reactor, was in the process of being commissioned.

Following German reunification in October 1990, comprehensive safety assessments of the Soviet type NPPs were carried out. These analyses showed safety deficiencies in comparison with the current West German nuclear safety requirements. Due to technical and economic reasons - in particular, uncertainties in the licensing process and also decreasing electricity consumption - it was decided to shut down these plants. Work on the nuclear plants under construction (units 6, 7 and 8 at Greifswald with WWER-440/W-213 reactors and two WWER-1000 reactors near Stendal) was also abandoned.

Following the euphoria of the fifties and sixties, scepticism about nuclear power began to grow in the early 1970s. An increasing number of citizens were opposed to the risks of atomic energy, and in particular opposed the further expansion of nuclear power plants. In West Germany, names such as Wyhl and Brokdorf (planned nuclear power plants), Gorleben (waste management centre), Wackersdorf (reprocessing unit) and Kalkar (fast breeder) are a synonym for the protests against nuclear power. After the incident in Harrisburg in 1979, and finally after the disaster of Chernobyl in 1986, it became clear that the risks of nuclear power are not merely theoretical.

In 2000, the Government concluded an agreement with the electricity companies to phase out the utilisation of nuclear energy in a structured manner. The Atomic Energy Act was amended accordingly in April 2002. The legal ban on the construction of new NPPs was fixed. Each nuclear power plant was assigned a residual electricity volume such that the total output of the respective plant corresponds to an average 32-year lifetime. As electricity volumes can, in principle, be legally transferred between plants, it was not possible to forecast precise shut-down dates.

Since 2010, the Federal Government has been focusing on an energy mix, gradually replacing the conventional sources of energy with renewable energies. For a transitional period, nuclear energy should remain an indispensable part of the energy mix. The Atomic Energy Act was amended accordingly in December 2010. The legal ban on the construction of new nuclear power plants remained unchanged. The operating lives of the 17 nuclear power plants, determined by the amount of electricity allowed for production, were extended by granting further electricity production rights grossly equalling an additional 12 years, on average. The extension was converted into volumes of electricity for each plant on the basis of exact calculation.

The accident at the Japanese Fukushima Daiichi NPP and its severe consequences, triggered by a strong earthquake and subsequent tsunami on 11 March 2011, has led to a watershed in the peaceful use of nuclear energy in Germany. In the light of these events, the German Federal Government, together with the Minister Presidents of the *Länder* in which NPPs are operated, had the safety of all German NPPs reviewed by the Reactor Safety Commission (RSK) in close collaboration with the competent nuclear regulatory authorities of the *Länder*. Through an Ethics Commission on “Secure Energy Supply”, they also started a dialogue among German society on the risks involved in the use of nuclear power and on the possibility of an accelerated transition to the age of renewable energies.

Taking the results of the Reactor Safety Commission and the Ethics Commission on “Secure Energy Supply” as well as the absolute priority of nuclear safety into account, the Federal Government decided to terminate the use of nuclear energy by the year 2022. The amendments in the Atomic Energy Act went into force in August 2011. According to them, the authorization to operate a NPP (installation for the fission of nuclear fuel for the commercial generation of electricity) shall expire when its electricity production rights have been exhausted, but not later than the end of

- 6 August 2011 for Biblis A, Neckarwestheim 1, Biblis B, Brunsbüttel, Isar 1, Unterweser, Philippsburg 1 and Krümmel NPPs,
- 31 December 2015 for Grafenrheinfeld NPP,
- 31 December 2017 for Gundremmingen B NPP,
- 31 December 2019 for Philippsburg 2 NPP,
- 31 December 2021 for Grohnde, Gundremmingen C and Brokdorf NPPs,
- 31 December 2022 for Isar 2, Emsland and Neckarwestheim 2 NPPs.

The Atomic Energy Act of 2011 assigns the electricity volumes for each individual nuclear power plant that had already been set out in the version of the Atomic Energy Act of April 2002. Thus, the extension of operating times by additional electricity volumes, as laid down in December 2010, was withdrawn.

2.1.2. Current organizational chart(s)

For the organizations of the regulatory body please refer to chapter 3.1.1.

The interaction of the different authorities and organizations involved in the nuclear licensing and supervision procedure is shown in Figure 1. The licensing procedure and the continuous regulatory supervision of the facilities lie within the responsibility of the individual *Länder* (federal states), see Table 7. To preserve legal uniformity for the entire territory of the Federal Republic of Germany, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit* - BMU) oversees the licensing and supervisory activities of the *Länder* authorities regarding lawfulness and expediency. [5].

The subordinate authority to the BMU in the area of radiation protection and nuclear safety is the Federal Office for Radiation Protection (*Bundesamt für Strahlenschutz* – BfS). The BfS supports the BMU technically and scientifically, especially in the execution of oversight with regards to legality and expediency, the preparation of legal and administrative procedures, and in intergovernmental co-operation.

The BMU receives regular advisory support from the Reactor Safety Commission (*Reaktor-Sicherheitskommission* - RSK), the Commission on Radiological Protection

(*Strahlenschutzkommission* - SSK) and the Nuclear Waste Management Commission (*Entsorgungskommission* - ESK). The commissions are independent and their members reflect the whole spectrum of scientific and technical opinions. Besides advising the BMU on issues of fundamental importance, they also initiate developments directed at furthering safety technology.

The main expert organisation advising the BMU on technical issues is the *Gesellschaft für Anlagen- und Reaktorsicherheit* (GRS). This central expert organisation performs scientific research in the field of nuclear safety technology, predominately sponsored by federal funds.

The involvement of authorized experts is based on special technical knowledge and independence. In this area the Technical Inspection Agencies (*Technischer Überwachungs-Verein* - TÜV) act on behalf of the *Länder* authorities. The *Länder* authorities are not bound by the authorised experts' evaluation results in making their decision.

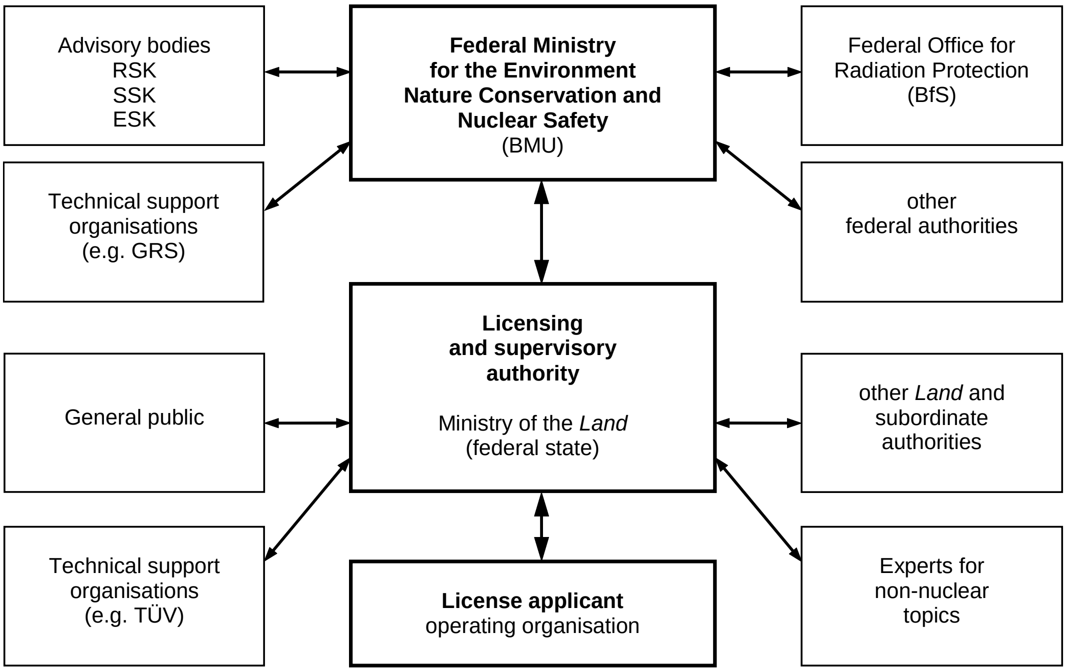


FIGURE 1: PARTICIPANTS IN THE NUCLEAR LICENSING AND SUPERVISION PROCEDURE

TABLE 7: THE *LÄNDER* LICENSING AND SUPERVISORY AUTHORITIES FOR NPPS

Land	**Nuclear Installation**	**Licensing Authority**	**Supervisory Authority**
Baden-Württemberg	Neckarwestheim 1 Neckarwestheim 2 Philippsburg 1 Philippsburg 2	Ministry for the Environment, Climate Protection and Energy Sector *in agreement with Ministry of Finance and Economic Affairs and Ministry of the Interior*	Ministry for the Environment, Climate Protection and Energy Sector
Bavaria	Isar 1 Isar 2 Grafenrheinfeld Gundremmingen B Gundremmingen C	Bavarian State Ministry of the Environment and Public Health *in agreement with State Ministry of the Economy, Infrastructure, Transport and Technology*	Bavarian State Ministry of the Environment and Public Health
Hesse	Biblis A Biblis B	Hessian Ministry of the Environment, Energy, Agriculture and Consumer Protection	
Lower Saxony	Unterweser Grohnde Emsland	Lower Saxon Ministry for Environment and Climate Protection	
Schleswig-Holstein	Brunsbüttel Krümmel Brokdorf	Ministry of Justice, Equality and Integration of Land Schleswig-Holstein	

2.2. Nuclear power plants: overview

2.2.1. Status and performance of nuclear power plants

In 2010, a total gross capacity of 21.5 GWe was installed in the 17 operating German nuclear power plants, comprising 11 pressurized water reactors (PWR) and 6 boiling water reactors (BWR). Table 8 shows the status of nuclear power plants by the end of 2010, Figure 2 their geographical location. On 6 August 2011, eight NPPS with a gross capacity of 8,821 MWe were finally shut down (Biblis A, Neckarwestheim 1, Biblis B, Brunsbüttel, Isar 1, Unterweser, Philippsburg 1 and Krümmel). Since then, nine NPPs (seven PWR and two BWR) are in operation with a gross capacity of 12,696 MWe.

According to the current legal situation, the right for operation will expire at fixed shutdown dates or even before if the electricity volume for that installation, as listed in the Atomic Energy Act or as derived from an allowable transfer of electricity volume, has been produced. In December 2010 additional electricity volumes were assigned to each NPP in order to extend the lifetimes. Table 9 shows the residual electricity volumes of the German NPPs as of 31 December 2010. Following the nuclear accident at NPP Fukushima Daiichi, the additional assigned electricity volumes of December 2010 were withdrawn (column 3 of Table 9). Since 6 August 2011, the electricity volumes as laid down in the Atomic Energy Act before December 2010 are effective (column 2 of Table 9).

In 2010 (2009), nuclear power plants contributed approximately 22.7% (22.6%) to the gross electricity production, which corresponds to 140.5 (134.9) TWh. The average availability of German nuclear power plants is shown in Table 10.

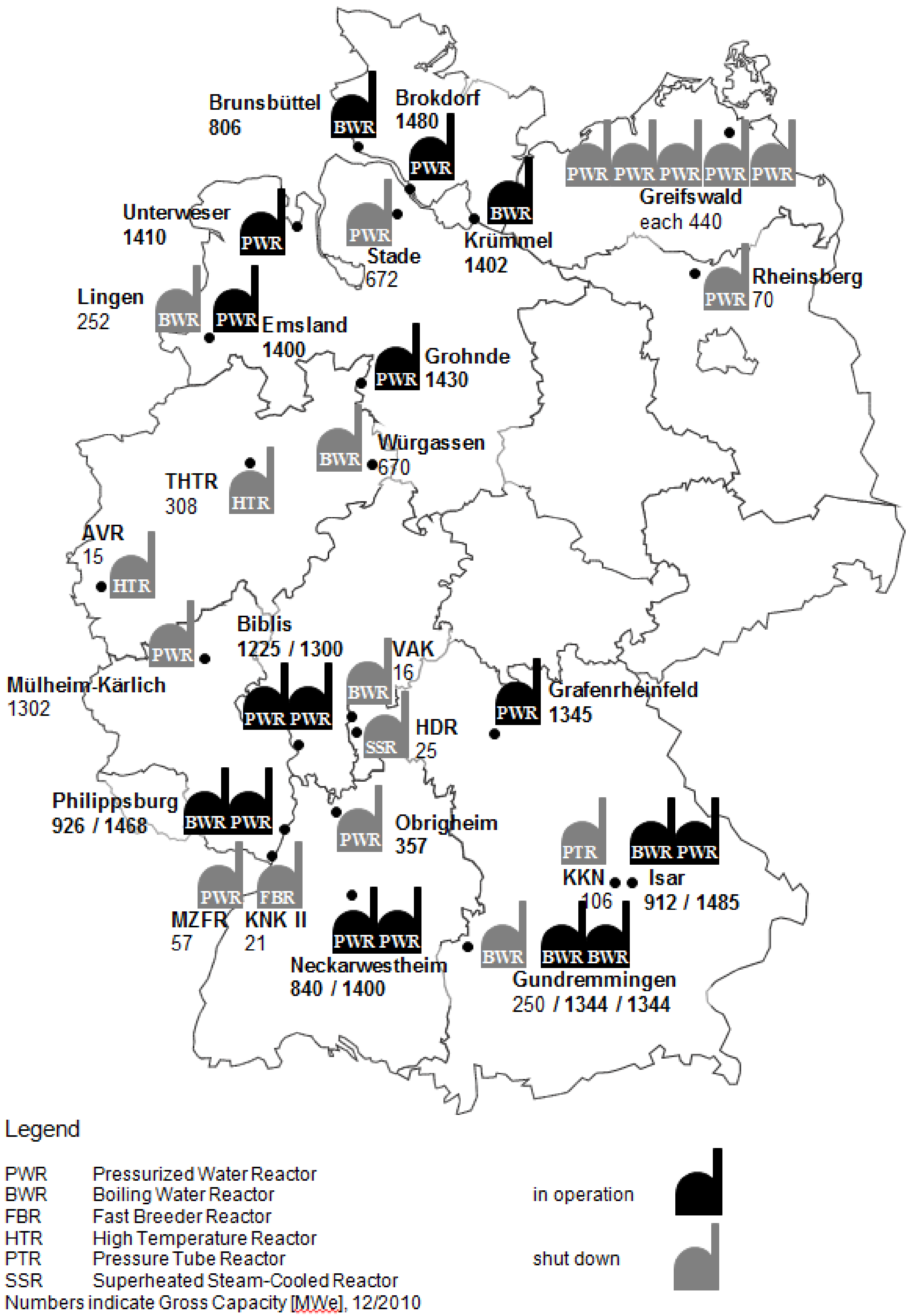
As of December 2010, 19 nuclear power plants have been permanently shut down. Of these, 15 facilities are currently being dismantled with "green-field conditions" being the planned target, two are in safe enclosure and two have already been completely dismantled to green-field conditions. Six other nuclear power plants never commenced operations as the projects were abandoned during the construction phase. Further information (shut down date and reason etc.) is shown in Table 11, dated 31 December 2010. For the eight NPPs shut down in August 2011 due to the nuclear accident in Fukushima Daiichi, no application for decommissioning has been filed as yet.

In total, 46 research reactors were built and operated in Germany. At present, most research reactors are shut down and being decommissioned. Eight research facilities – three with a capacity of more than 50 kW thermal power and five small training reactors – are still in operation.

TABLE 8: STATUS AND PERFORMANCE OF NUCLEAR POWER PLANTS AS OF 31 DECEMBER 2010

Plant	Type	Net Capacity	Status	Operator	Reactor Supplier	Construction Date	Criticality Date	Grid Date	Commercial Date	Shutdown Date
BIBLIS-A (KWB A)	PWR	1167	Operational	RWE	KWU	01-Jan-70	16-Jul-74	25-Aug-74	26-Feb-75	*)
BIBLIS-B (KWB B)	PWR	1240	Operational	RWE	KWU	01-Feb-72	25-Mar-76	25-Apr-76	31-Jan-77	*)
BROKDORF (KBR)	PWR	1410	Operational	E.ON	KWU	01-Jan-76	08-Oct-86	14-Oct-86	22-Dec-86	
BRUNSBUETTEL (KKB)	BWR	771	Operational	KKB	KWU	15-Apr-70	23-Jun-76	13-Jul-76	09-Feb-77	*)
EMSLAND (KKE)	PWR	1329	Operational	KLE	SIEM, KWU	10-Aug-82	14-Apr-88	19-Apr-88	20-Jun-88	
GRAFENRHEINFELD (KKG)	PWR	1275	Operational	E.ON	KWU	01-Jan-75	09-Dec-81	30-Dec-81	17-Jun-82	
GROHNDE (KWG)	PWR	1360	Operational	E.ON	KWU	01-Jun-76	01-Sep-84	04-Sep-84	01-Feb-85	
GUNDREMMINGEN-B (KRB B)	BWR	1284	Operational	KGG	KWU	20-Jul-76	09-Mar-84	16-Mar-84	19-Jul-84	
GUNDREMMINGEN-C (KRB C)	BWR	1288	Operational	KGG	KWU	20-Jul-76	26-Oct-84	02-Nov-84	18-Jan-85	
ISAR-1 (KKI 1)	BWR	878	Operational	E.ON	KWU	01-May-72	20-Nov-77	03-Dec-77	21-Mar-79	*)
ISAR-2 (KKI 2)	PWR	1410	Operational	E.ON	KWU	15-Sep-82	15-Jan-88	22-Jan-88	09-Apr-88	
KRUEMMEL (KKK)	BWR	1346	Operational	KKK	KWU	05-Apr-74	14-Sep-83	28-Sep-83	28-Mar-84	*)
NECKARWESTHEIM-1 (GKN 1)	PWR	785	Operational	EnBW	KWU	01-Feb-72	26-May-76	03-Jun-76	01-Dec-76	*)
NECKARWESTHEIM-2 (GKN 2)	PWR	1310	Operational	EnBW	SIEM, KWU	09-Nov-82	29-Dec-88	03-Jan-89	15-Apr-89	
PHILIPPSBURG-1 (KKP 1)	BWR	890	Operational	EnBW	KWU	01-Oct-70	09-Mar-79	05-May-79	26-Mar-80	*)
PHILIPPSBURG-2 (KKP 2)	PWR	1402	Operational	EnBW	KWU	07-Jul-77	13-Dec-84	17-Dec-84	18-Apr-85	
UNTERWESER (KKU)	PWR	1345	Operational	E.ON	KWU	01-Jul-72	16-Sep-78	29-Sep-78	06-Sep-79	*)
AVR JUELICH (AVR)	HTGR	13	Shut Down	AVR	BBK	01-Aug-61	16-Aug-66	17-Dec-67	19-May-69	31-Dec-88
GREIFSWALD-1(KGR 1)	WWER	408	Shut Down	EWN	AEE, KAB	01-Mar-70	03-Dec-73	17-Dec-73	12-Jul-74	18-Dec-90
GREIFSWALD-2 (KGR 2)	WWER	408	Shut Down	EWN	AEE, KAB	01-Mar-70	03-Dec-74	23-Dec-74	16-Apr-75	14-Feb-90
GREIFSWALD-3 (KGR 3)	WWER	408	Shut Down	EWN	AEE, KAB	01-Apr-72	06-Oct-77	24-Oct-77	01-May-78	28-Feb-90
GREIFSWALD-4 (KGR 4)	WWER	408	Shut Down	EWN	AEE, KAB	01-Apr-72	22-Jul-79	03-Sep-79	01-Nov-79	02-Jun-90
GREIFSWALD-5 (KGR 5)	WWER	408	Shut Down	EWN	AEE, KAB	01-Dec-76	26-Mar-89	24-Apr-89	-	30-Nov-89
GUNDREMMINGEN-A (KRB A)	BWR	237	Shut Down	KGB	AEG, GE	12-Dec-62	14-Aug-66	01-Dec-66	12-Apr-67	13-Jan-77
HDR GROSSWELZHEIM	BWR	23	Shut Down	FZK	AEG, KWU	01-Jan-65	14-Oct-69	14-Oct-69	02-Aug-70	20-Apr-71
KNK II	FBR	17	Shut Down	FZK	IA	01-Sep-74	10-Oct-77	09-Apr-78	03-Mar-79	23-Aug-91
LINGEN (KWL)	BWR	240	Shut Down	KWL	AEG	01-Oct-64	31-Jan-68	01-Jul-68	01-Oct-68	05-Jan-77
OBRIGHEIM (KWO)	PWR	340	Shut Down	KWO	SIEM, KWU	15-Mar-65	22-Sep-68	29-Oct-68	01-Apr-69	11-May-05
MUELHEIM-KAERLICH (KMK)	PWR	1219	Shut Down	RWE	BBR	15-Jan-75	01-Mar-86	14-Mar-86	01-Oct-87	09-Sep-88
MZFR	PHWR	52	Shut Down	FZK	SIEMENS	01-Dec-61	29-Sep-65	09-Mar-66	19-Dec-66	03-May-84
NIEDERAICHBACH (KKN)	HWGCR	100	Shut Down	FZK	SIEM, KWU	01-Jun-66	17-Dec-72	01-Jan-73	01-Jan-73	31-Jul-74
RHEINSBERG (KKR)	PWR	62	Shut Down	EWN	AEE, KAB	01-Jan-60	11-Mar-66	06-May-66	11-Oct-66	01-Jun-90
STADE (KKS)	PWR	640	Shut Down	E.ON	KWU	01-Dec-67	08-Jan-72	29-Jan-72	19-May-72	14-Nov-03
THTR-300	HTGR	296	Shut Down	HKG	HRB	01-May-71	13-Sep-83	16-Nov-85	01-Jun-87	29-Sept-88
VAK KAHL	BWR	15	Shut Down	VAK	GE, AEG	01-Jul-58	13-Nov-60	17-Jun-61	01-Feb-62	25-Nov-85
WUERGASSEN (KWW)	BWR	640	Shut Down	E.ON	AEG, KWU	26-Jan-68	20-Oct-71	18-Dec-71	11-Nov-75	26-Aug-94

*) shut down on 6 August 2011 according to amended Atomic Energy Act following nuclear accident in NPP Fukushima Daiichi.
Source: Country information year-end 2010 [6].



Source: Country Information [6]

FIGURE 2: NUCLEAR POWER PLANTS IN GERMANY AS OF 31 DECEMBER 2010

TABLE 9: RESIDUAL ELECTRICITY VOLUMES OF GERMAN NPPS AS OF 31 DECEMBER 2010 [TWH]

NPP	Residual Electricity Volume as of 1 January 2000 (Annex 3 of the Atomic Energy Act)	Additional Electricity Volumes granted in December 2010 – but withdrawn in August 2011	Net Electricity Volume Produced 1 January 2000 to 31 December 2010	Transfer of Electricity Volumes	Residual Electricity Volumes 31 December 2010
1	**2**	**3**	**4**	**5**	**6**
Biblis A (KWB A)	62.00	68.62	62.48	4.79	72.93
Biblis B (KWB B)	81.46	70.66	80.10	8.10	80.09
Brokdorf (KBR)	217.88	146.35	123.79		240.44
Brunsbüttel (KKB)	47.67	41.04	36.67		52.04
Emsland (KKE)	230.07	142.33	121.00		251.43
Grafenrheinfeld (KKG)	150.03	135.62	108.15		177.50
Grundremmingen B (KRB B)	160.92	125.76	110.70		175.99
Grundremmingen C (KRB C)	168.35	126.94	109.83		185.45
Grohnde (KWG)	200.90	150.44	119.25		232.09
Isar 1 (KKI 1)	78.35	54.98	74.76		58.57
Isar 2 KKI 2)	231.21	144.70	126.38		249.53
Krümmel (KKK)	158.22	124.16	69.97		212.41
Mülheim-Kärlich (KMK) [1)]	107.25	-	-	-8.10	99.15
Neckarwestheim 1 (GKN 1)	57.35	51.00	57.16		51.19
Neckarwestheim 2 (GKN 2)	236.04	139.79	115.49		260.34
Obrigheim (KWO) [2)]	8.70	-	14.20	5.50	0.00
Philippsburg 1 (KKP 1)	87.14	55.83	71.77	-5.50	65.7
Philippsburg 2 (KKP 1)	198.61	146.96	118.11		227.46
Stade (KKS) [3)]	23.18	-	18.39	-4.79	0.00
Unterweser KKU)	117.98	79.10	104.41		92.67

[1)] The NPP Mülheim-Kärlich was shut down in September 1988. The electricity volume of the NPP Mülheim-Kärlich can be transferred to KKE, GKN2, KKI2, KBR, KRB-B, KRB-C or a volume of up to 21.45 TWh may be transferred to KWB-B.
[2)] The NPP Obrigheim was shut down in May 2005.
[3)] The NPP Stade was shut down in November 2003.
Source: Country Information [6].

TABLE 10: AVERAGE AVAILABILITY OF GERMAN NUCLEAR POWER PLANTS

Year	Time availability [%]	Energy availability [%]	Capacity availability [%]
2010	76.4	77.5	74.0
2009	73.2	74.2	71.2
2008	80.0	80.9	78.4
2007	76.0	76.4	74.4
2006	91.1	90.8	89.1
2005	88.8	88.0	86.3
2000	90.0	90.6	85.9

Time availability: available operating time/calendar time
Energy availability: available energy/nominal energy
Capacity availability: energy generated/nominal energy
Source: Country Information [6].

TABLE 11: REACTORS IN DECOMMISSIONING PROCESS OR DECOMMISSIONED AS OF 31 DECEMBER 2010

Reactor name	**Shut down date**	**Shutdown reason**	**Decom. strategy**	**Current decom. phase**		**Current fuel management phase**	**Decom. licensee**
				start	end		
AVR Jülich (AVR)	31.12.1988	experimental program ended	dismantling	09.03.1994		interim storage at Jülich	AVR GmbH (part of EWN)
Greifswald-1 (KGR 1)	18.12.1990	safety concerns	dismantling	30.06.1995		interim storage Zwischenlager Nord (ZLN)	Energiewerke Nord GmbH (EWN)
Greifswald-2 (KGR 2)	14.02.1990	safety concerns	dismantling	30.06.1995		interim storage Zwischenlager Nord (ZLN)	Energiewerke Nord GmbH (EWN)
Greifswald-3 (KGR 3)	28.02.1990	safety concerns	dismantling	30.06.1995		interim storage Zwischenlager Nord (ZLN)	Energiewerke Nord GmbH (EWN)
Greifswald-4 (KGR 4)	02.06.1990	safety concerns	dismantling	30.06.1995		interim storage Zwischenlager Nord (ZLN)	Energiewerke Nord GmbH (EWN)
Greifswald-5 (KGR 5)	30.11.1989	economic	dismantling	30.06.1995		interim storage Zwischenlager Nord (ZLN)	Energiewerke Nord GmbH (EWN)
Grundremmingen-A (KRB-A)	13.01.1977	economic	dismantling	26.05.1983		reprocessing	Kernkraftwerk Grundremmingen GmbH
HDR Großwelzheim	20.04.1971	technical	dismantling	16.02.1983	15.10.1998	reprocessed in WAK	Karlsruher Institut für Technologie (KIT) former Forschungszentrum Karlsruhe GmbH (FZK)
KNK II	23.08.1991	experimental program ended	dismantling	26.08.1993		final disposal in Cadarache (F)	Wiederaufbereitungsanlage Karlsruhe Rückbau- und Entsorgungs-GmbH (part of EWN)
Lingen (KWL)	05.01.1977	economic	safe enclosure	21.11.1985		transport to Sellafield (GB)	Kernkraftwerk Lingen GmbH
Mülheim-Kärlich (KMK)	09.09.1988	phase out regulation	dismantling	16.07.2004		reprocessed in La Hague (F)	RWE Power AG
MZFR	03.05.1984	experimental program ended	dismantling	17.11.1987		reprocessed in WAK	Wiederaufbereitungsanlage Karlsruhe Rückbau- und Entsorgungs-GmbH (part of EWN)
Niederaichbach (KKN)	31.07.1974	technical	dismantling	21.10.1975	17.08.1995	transported to Commissariat à l'Energie Atomique	Karlsruher Institut für Technologie (KIT) former Forschungszentrum Karlsruhe GmbH (FZK)
Obrigheim (KWO)	11.05.2005	phase out regulation	dismantling	[2]8.08.2008		dry interim storage is planned	EnBW Kernkraft GmbH (EnKK)
Rheinsberg (KKR)	01.06.1990	safety concerns	dismantling	28.04.1995		interim storage Zwischenlager Nord (ZLN)	Energiewerke Nord GmbH (EWN)

Reactor name	Shut down date	Shutdown reason	Decom. strategy	Current decom. phase		Current fuel management phase	Decom. licensee
				start	end		
Stade (KKS)	14.11.2003	phase out regulation	dismantling	07.09.2005		reprocessed in France	E.ON Kernkraft GmbH
THTR-300	29.09.1988	economic, technical	safe enclosure	22.10.1993		interim storage at Ahaus	HKG
VAK Kahl	25.11.1985	experimental program ended	dismantling	05.05.1988	24.09.2010	reprocessed in WAK/ disposal in Sweden	VAK
Würgassen (KWW)	26.08.1994	economic	dismantling	14.04.1997		reprocessed in La Hague (F)	E.ON Kernkraft GmbH

Source: Country Information [6].

2.2.2. Plant upgrading, plant life management and license renewals

Planned modifications of a nuclear power plant are to be assessed systematically with regards to the impacts on the safety level of the nuclear power plant. Modifications obviously having only insignificant impacts on the safety level do not require a licensing procedure, but rather require accompanying inspections by the safety authorities within the framework of the supervisory procedure. Significant modifications of a nuclear power plant or its operations require a license from the competent authority (see chapter 3.1.2).

All operators of German nuclear power plants are obliged to perform comprehensive quality management, based on provisions for quality assurance specified in the Safety Criteria published by the Federal Ministry for the Environment, Nature Protection and Nuclear Safety and in the nuclear safety standards of the Nuclear Safety Standard Commission (*Kerntechnischer Ausschuss* - KTA). The supervisory authority controls the result of the audits performed by the plant operator, and the implementation of measures derived from it within the framework of on-site inspections. Ageing Management, i.e. measures for maintaining quality over a long period of time, is an integral part of the quality requirements.

According to the Atomic Energy Act, safety reviews (SR) have to be carried out at prescribed dates and are to be repeated every ten years. SRs are performed according to standardized national criteria and consist of a deterministic and a probabilistic part. SRs supplement the regulatory supervision and inspection of nuclear power plants. The results have to be submitted to the supervisory authority and are usually assessed by independent experts who act by order of the supervisory authority. The obligation to present the SR results is lifted if the licensee makes the binding declaration to the licensing and supervisory authority that he is definitively going to terminate power operation at the plant no later than three years after the final date for submission of the SR mentioned in the Atomic Energy Act.

As the licenses for the operation of NPPs are not limited in time, no renewal is required, notwithstanding the legal provisions for the phase-out of nuclear electricity production.

For further information see [5].

2.3. Future development of nuclear power

No new developments planned. For further details on nuclear energy policy see chapter 1.2.3.

2.4. Organizations involved in construction of NPPs

All nuclear power plants currently in operation in Germany were constructed by *Kraftwerk-Union* (KWU, founded by *Siemens* and *AEG*) in the 1970s and 1980s. KWU, a 100% subsidiary of *Siemens AG* for a long time, was transferred to a French-German joint venture in 2001, in which the French *AREVA* had a shareholding of approximately two thirds and *Siemens AG* of one third. Since April 2006, the joint venture has operated under the name of *AREVA NP*. In March 2011, *AREVA NP* became a 100% subsidiary of *AREVA.*

The company *Babcock-Brown Boveri Reaktor GmbH* (BBR, a joint venture of *Brown, Boveri & Cie.* and *Babcock&Wilcox* from the USA, later *ABB*, respectively sold to BNFL/UK in December 1999, now renamed *Westinghouse*) supplied the PWR plant Mülheim-Kärlich, which was shut down in 1988.

German utilities, together with *Siemens*/KWU and in close co-operation with its French counterparts (*EdF* and *Framatome*), developed the European Pressurized Water Reactor EPR with enhanced safety features. The EPR is currently built in Finland and France. German utilities also supported the *Siemens*/KWU development of an advanced BWR (SWR 1000) with additional passive safety features.

No exclusively German supplier of NPPs remained upon the start of the 21st century. In 2001, the remaining domestic manufacturer, *Siemens*/KWU, merged its nuclear business with *Framatome SA*, which in the meantime became part of the French *AREVA* Group as *AREVA NP*. The main activities are projects and engineering, nuclear services, nuclear fuel and mechanical equipment. Under French management, the former KWU employees are also engaged in EPR activities in Finland and France.

The second German supplier for NPPs, BBR, meanwhile part of *Westinghouse*, now concentrates on nuclear services.

2.5. Organizations engaged in operation of NPPs

See Table 8

EnBW Kernkraft GmbH-EnKK, as part of the holding company *EnBW-Energie-Baden-Württemberg AG*, operates the four NPPs Neckarwestheim-1 and -2 and Philippsburg-1 and -2. The NPPs Brokdorf, Grafenrheinfeld, Grohnde, Isar-1 and -2 and Unterweser are operated by *E.ON Kernkraft GmbH*, which is a subsidiary company of *E.ON Energie AG*. The company *RWE Power AG* operates the NPPs Biblis A and B. The NPPs Grundremmingen B and C are operated by *Kernkraftwerk Grundremmingen GmbH-KGG*; the shareholders of this company are *RWE Power AG* (75%) and *E.ON Kernkraft GmbH* (25%). The NPP Emsland is operated by *Kernkraftwerke Lippe-Ems GmbH-KLE*, which is held by *RWE Power AG* (87.5%) and *E.ON Kernkraft GmbH* (12.5%). *Kernkraftwerk Brunsbüttel GmbH & Co. oHG-KKB*, held by *Vattenfall Europe Nuclear Energy GmbH* (66.6%) and *E.ON Kernkraft GmbH* (33.3%), operates the NPP Brunsbüttel. *Vattenfall Europe Nuclear Energy GmbH* and *E.ON Kernkraft GmbH* are also shareholders in equal parts of *Kernkraftwerk Krümmel GmbH & Co. oHG-KKK*, which operates the NPP Krümmel.

2.6. Organizations involved in decommissioning of NPPs

The decommissioning licensee, as mentioned in Table 11, is responsible for the decommissioning of the nuclear power plant. For decommissioning, a license is required from the competent licensing authority of the *Land* in which the nuclear installation is sited. The licensing and supervisory process is described in chapter 3.1.1 and 3.1.2 of this report.

2.7. Fuel cycle including waste management

All facilities necessary to close the nuclear fuel cycle have been realized or were projected in Germany. Today, only a few of them are in operation. Several facilities have been shut down and are being decommissioned, while others did not receive an operation license.

- Mining and milling

In Germany, search for mines containing uranium ore began very early. However, due to economic reasons only a few mines were of interest, and were operated as pilot mines. In 1961, West Germany erected a very small utility for yellow cake production at Ellweiler. The supervisory authority stopped work in 1989. The facility was decommissioned and restoration was finalized in 2000. In East Germany, the large uranium production facility *Wismut* was erected, initially supplying uranium also to the Soviet Union. This facility is being decommissioned.

- Uranium enrichment

At the enrichment plant at Gronau (*URENCO* Germany), natural uranium in the form of uranium hexafluoride is enriched via centrifuge cascades to a maximum of 6% by weight of fissionable U-235. The facility started operation in 1985, with a capacity of 400 kSWU/year. After the licensed capacity reached 1,800 kSWU/year, an expansion to a capacity of 4,500 kSWU/year was licensed in 2005. The expanded plant has been under construction since 2008 and will be commissioned gradually. In September 2010, the production capacity amounted to 3,420 kSWU/year.

- Fuel fabrication

At Lingen, the Fuel Element Fabrication Plant *ANF* (*Advanced nuclear fuels GmbH*) is in operation since 1979, and produces uranium fuel elements for light water reactors. In 2009, the conversion facility was licensed a capacity of 800 Mg of uranium per year.

At the Siemens Fuel Element Fabrication Plant Hanau (*Siemens Brennelementewerk Hanau*, *Siemens AG*), mixed-oxide (MOX) fuel elements and uranium fuel elements for light water reactors were produced from 1968 until 1991 and from 1969 until 1995, respectively. The facility was finally decommissioned in 2006. The Siemens Fuel Element Fabrication Plant Karlstein (*Siemens Brennelementewerk* at Karlstein, *Siemens AG*) started in the year 1966 with the production of special fuel elements using low enriched uranium dioxide. Decommissioning of this plant was finalized in 1999. At the NUKEM Fuel Element Fabrication Plant Hanau (*Brennelementefabrik* at Hanau), the company *NUKEM* produced special fuel elements consisting of uranium and thorium for research reactors, from 1962 until 1988. The decommissioning process has been finalized for this plant (status: installation was removed, clearance of the site). The company *Hochtemperatur-Brennelement-Gesellschaft-HOBEG* operated a fuel fabrication for the production of spherical fuel elements, composed of highly enriched uranium and thorium for high temperature reactors, from 1972 until 1988, at Hanau. The utility was finally decommissioned in 1995.

- Interim storage of spent fuel

Three central interim storage facilities for spent fuel are in operation: the Transport Cask Storage Facility *Ahaus* (TBL-A), for irradiated fuel and other radioactive substances, the Transport Cask Storage Facility *Gorleben* (TBL-G), for both irradiated fuel and vitrified reprocessing products, and the Transport Cask Storage Facility in the interim storage facility North Rubenow (*Zwischenlager Nord* -ZLN), for spent fuel elements, nuclear fuel, and other radioactive waste from decommissioning the NPPs Greifswald and Rheinsberg. In 2009 the *Zwischenlager Nord* was licensed to store vitrified waste from the shut-down pilot reprocessing plant at Karlsruhe (*WAK*).

Twelve on-site interim storage facilities at the sites of NPPs have been licensed and are all in operation (last one started operation in June 2007). An additional on-site interim storage facility is under planning, with the licensing procedure on-going. [8]

- Reprocessing

In Germany, the development of reprocessing technologies started in the 1960s. In 1989, the plans for reprocessing were abandoned and it was intended to transport irradiated fuel elements into other member states of the European Union for interim storage and reprocessing. These transports were outlawed in 2002, with the last transport allowed in 2005. At that time, the direct final disposal of fuel elements became the aim of waste management.

The pilot reprocessing plant at Karlsruhe (*Wiederaufarbeitungsanlage Karlsruhe* - *WAK*) operated from 1971 until 1990. The facility has been decommissioned and is in the process of being dismantled. The highly radioactive solutions of fission products (HAWC – High Active Waste Concentrate) present at this plant were vitrified at the on-site vitrification plant from September 2009 to November 2010. In total, 56 tons of vitrified waste were produced and shipped to the interim storage facility *Zwischenlager Nord*.

The project for a reprocessing plant at Wackersdorf (*Wiederaufarbeitungsanlage Wackersdorf* - *WAW*) started 1982 and was abandoned in 1988. [8]

- Waste management (radioactive waste from complete fuel cycle)

It is intended to dispose of all types of radioactive waste in deep geological formations. In order to find a suitable site for a final repository for heat-generating waste, work is in progress to prepare an Act on Site Selection Procedure. The Federal Office for Radiation Protection (*Bundesamt für Strahlenschutz* - *BfS*) is responsible – inter alia - for the construction and operation of nuclear waste repositories. To fulfil its tasks the *BfS* may employ the services of a third party. The *BfS* exercises this option: the third party in question is the *Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH* (DBE).

Development work in this field started in West Germany with the *Asse* research mine - a salt dome in Lower Saxony - where low and medium level radioactive waste was disposed from 1967 until 1978. After 1978, research and development on the safe disposal of radioactive waste was performed until 1992, in *Asse* without any further emplacement. In 2008, it was decided to change the license basis, ownership and operating organisation. Since the beginning of 2009, the *BfS* has taken over responsibility for the *Asse* mine. A closure concept is now in preparation. In the late 1960s, East Germany erected a repository at the former salt dome *Morsleben*, where low and medium level waste was emplaced until 1998. The licensing procedure for decommissioning is currently in progress. In 1979, the salt dome of *Gorleben* was assessed for its suitability as a repository for all types of radioactive waste, in particular for high level waste. Exploration work started in 1985. In 2000, this work was interrupted for a minimum of three and maximum of ten years (Gorleben moratorium). In October 2010, the moratorium ended and the *BfS* resumed the exploration activities of the *Gorleben* salt dome. The former iron ore *Schacht Konrad* was licensed as repository in May 2002, where all radioactive waste with negligible heat generation should be disposed. Finally, in March 2006, all suits against this repository were rejected by court. Complaints against this decision were dismissed in April 2007. The Federal Office for Radiation Protection is in charge of converting the mine into a safe repository.

The controlled and safe disposal of radioactive waste requires its conditioning prior to entering the repository. In *Gorleben*, a pilot conditioning plant was erected for the conditioning of spent fuel assemblies for direct disposal, but at present only a limited operation license, to repair defective transport and storage casks for spent fuel assemblies and HAW glass canisters, has been granted (since 2000). [8]

2.8. Research and development

2.8.1. R&D Organizations

See Appendix 2

Safe operation of nuclear power plants is a top priority for the Federal Government, and consequently research in this field is continued and extended.

In 2010, the Energy R&D Programme of the Federal Government supported research on nuclear safety and waste disposal with a total amount of € 71.5 million.

Within the government, the Federal Ministry of Economics and Technology (*Bundesministerium für Wirtschaft und Technologie - BMWi*) currently provides approximately € 20 million annually for reactor safety research. Amongst others, experimental or analytical studies of the plant behaviour of light water reactors under accident conditions, studies concerning the safety of pressure retaining components and the development of probabilistic safety analysis are funded. Approximately a further € 10 million is spent on repository and nuclear waste research.

The Federal Ministry of Education and Research (*Bundesministerium für Bildung und Forschung - BMBF*) promotes projects and institutions with funds of around € 40 million, focussing on basic science issues regarding waste disposal, reactor research and radiology. As a long term energy option, the development of fusion reactors is currently supported by BMBF through research projects (€ 10 million) and institutional funding (around € 140 million).

2.8.2. Development of advanced nuclear power technologies

Two prototypes of advanced reactor design were developed in Germany: the pebble-bed high-temperature reactor (*Thorium-Hochtemperaturreaktor*, THTR 300) at HRB/BBC and a fast breeder reactor (*Schneller Natriumgekühlter Reaktor*, SNR 300) at Interatom/Siemens. After successful commissioning and operation for some years, the THTR 300 was shut down. The SNR 300 was completed but never commissioned.

2.8.3. International co-operation and initiatives

See Appendix 1

As member state of the EU, OECD/NEA, and IAEA, Germany supports various international programmes in nuclear safety and nuclear waste management. In direct international co-operation, Germany also supports projects and organizations, e.g. the licensing and supervisory authorities, technical support organizations and also research institutes.

As EU member, Germany takes part in many European nuclear research activities within the 7th Framework Programme, e.g.:

- SARNET2 (Severe accident research network)
- INSC projects (Instrument for Nuclear Safety Cooperation),
- IPA projects (Instrument for Pre Accession)

As NEA member, Germany participates, among other things, in:

- the Behaviour of Iodine Project (BIP-2)
- the Cabri Water Loop Project
- the Component Operational Experience, Degradation and Ageing Programme (CODAP) Project
- the Computer-based Systems Important to Safety (COMPSIS) Project
- the Co-operative Programme on Decommissioning (CPD)
- the Fire Incidents Records Exchange (FIRE) Project
- the Fire Propagation in Elementary, Multi-room Scenarios (PRISME-2) Project
- the Halden Reactor Project
- the Information System on Occupational Exposure (ISOE)
- the International Common-cause Failure Data Exchange (ICDE) Project
- the Loss of Forced Coolant (LOFC) Project
- the Melt Coolability and Concrete Interaction (MCCI-2) Project (completed)
- the Piping Failure Data Exchange (OPDE) Project (completed)
- the Primary Coolant Loop Test Facility (PKL-2) Project
- the PSB-VVER Project (completed)
- the Rig of Safety Assessment (ROSA-2) Project
- the Sandia Fuel Project (SFP)
- the SESAR Thermal-hydraulics (SETH-2) Project (completed)
- the Sorption Project (completed)
- the Source Term Evaluation and Mitigation (STEM) Project
- the Steam Explosion Resolution for Nuclear Applications (SERENA) Project
- the Stress Corrosion Cracking and Cable Ageing Project (SCAP) (completed)
- the Studsvik Cladding Integrity (SCIP-2) Project
- the Thermal-hydraulics, Hydrogen, Aerosols, Iodine (ThAI-2) Project
- the Thermochemical Database (TDB) Project

For project descriptions see http://www.nea.fr/html/jointproj/welcome.html

2.9. Human resources development

The need for provision of sufficient and qualified personnel is defined in the Radiation Protection Ordinance and the Atomic Energy Act. Proof of the qualifications of responsible personnel as well as the necessary knowledge of personnel otherwise engaged during operation must already be considered in the license application for construction, operation or essential modification. Detailed requirements for the technical qualification of personnel are specified in guidelines. In addition, guidelines stipulate the qualifications of responsible shift personnel and their maintenance, as well as the qualifications of personnel responsible for radiation protection. The measures taken by the operator to ensure adequate staffing are reviewed by the supervisory authority, on the basis of submitted reports.

German nuclear power plants currently in operation are staffed by personnel with extensive experience in the operation of nuclear power plants. These employees undergo regular job-specific retraining on plant-specific, full-scope simulators at the Simulator Centre (*Simulatorzentrum)* in

Essen. On average, about 350 own plant employees and about 150 employees of contractors are employed all year round, per unit. During plant outage for refuelling and annual inspection, the number of external personnel is increased to approximately 1000 employees.

Due to demographic personnel development, a forward-looking personnel management system is implemented for maintenance of competence and quantity of personnel. On the basis of expected retirements, as well as statistical forecasts, plant operators typically plan the need for replacement recruitment up to five years in advance. Systematic training programmes and a long-running “parallel recruitment” system are in place to ensure the transfer of know-how.

2.10. Stakeholder communication

Since 2000, a monitoring group of representatives of government and nuclear power plant operators meets on a regular basis to discuss current issues around the development of nuclear power in Germany.

3. NATIONAL LAWS AND REGULATIONS

3.1. Regulatory framework

Germany is organized as a federal republic. The responsibilities for legislation and law enforcement are assigned to the organs of the Federation and the *Länder* according to their scope of function. Unless otherwise specified, the execution of federal laws lies within the responsibility of the federal states, the 16 *Länder*.

According to the Basic Law (*Grundgesetz*) the Federal Government has the legislative competence for the peaceful use of nuclear energy. The Basic Law also states that the Atomic Energy Act is executed - with some exceptions - by the *Länder* on behalf of the Federal Government. In this respect, the *Länder* authorities are under the oversight of the Federation with regard to legality and expediency of their actions.

In the hierarchy of legislation, international treaties concluded by the Federal Republic of Germany are on the same level as formal federal law.

In addition, legislation and its execution must take into account any binding requirement from the law of the European Union. In accordance with the Euratom Treaty, any use of ores, source material and special fissile material is subject to the Safeguards of the European Atomic Energy Community. Examples for relevant secondary law instruments on the basis of the Euratom Treaty are Directive 96/29/Euratom, laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation, Directive 2009/71/Euratom, establishing a Community framework for the nuclear safety of nuclear installations and Directive 2011/70/Euratom, establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.

The IAEA Safety Standards are not implemented into national regulations, but national regulations are comparable and much more detailed.

3.1.1. Regulatory authority(ies)

See also chapter 2.1.2.

As Germany is organized as a federal state, the execution of federal laws lies in principle within the sole responsibility of the federal states, the *Länder*, unless otherwise specified. The "Regulatory body" is therefore composed of Federal Government and *Länder* government authorities (see Figure 3 and Table 12).

By organisational decree, the Federal Government names the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit - BMU*) as the supreme regulatory authority in charge of nuclear safety and radiation protection. The *BMU* is responsible for federal oversight of the lawfulness and expediency of the actions of the *Länder*, including the right to issue binding directives. The subordinate authority to the

BMU is the Federal Office for Radiation Protection (*Bundesamt für Strahlenschutz - BfS*). This supports the *BMU* technically and scientifically, especially in the execution of federal oversight, the preparation of legal and administrative procedures, and in intergovernmental co-operation.

According to the Atomic Energy Act, the respective *Länder* governments determine the supreme *Länder* authorities in charge of the licensing and supervision of nuclear power plants (see Table 7). For technical matters in the licensing procedure and the supervision of nuclear facilities, the regulatory authorities of the *Länder* are supported by independent technical support organizations, in general the nuclear departments of the technical support organizations (e.g. TÜV).

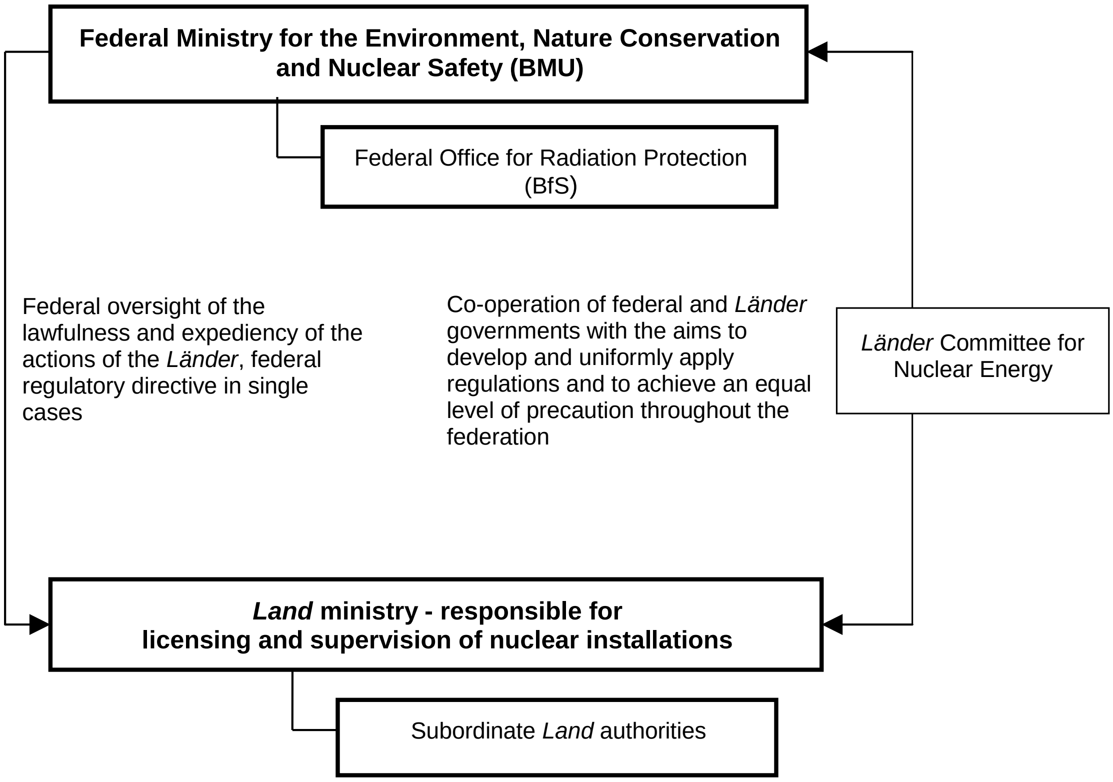


FIGURE 3: ORGANISATION OF THE REGULATORY BODY

TABLE 12: ASSIGNMENT OF THE REGULATORY FUNCTIONS TO THE NUCLEAR AUTHORITIES OF THE FEDERATION AND THE LÄNDER

	Functions and responsibilities of the regulatory body	
Regulatory function	**Federal Government authorities**	***Länder* government authorities**
Main functions		
Establishment of national safety requirements and regulations	Further development of the legal requirements (decided by Parliament in the case of formal Acts, by Federal Government with approval of the Bundesrat in the case of ordinances) and the regulatory guidance instruments	Participation on the basis of consolidated findings and needs in connection with execution Supplementary administrative procedures of the respective *Länder*
Licensing system with regard to nuclear installations	Oversight with regard to legality and expediency* Checking of consolidated findings with regard to their relevance to standard national requirements	Checking of applications and notifications according to Section 7 of the Atomic Energy Act, granting of licenses and approvals

Regulatory function	Functions and responsibilities of the regulatory body Federal Government authorities	*Länder* government authorities
System of regulatory inspection and assessment of nuclear installations	Oversight with regard to legality and expediency* Checking of consolidated findings with regard to their relevance to standard national requirements	Controls and inspections in the nuclear facilities, checks and assessments with regard to the relevance and safety of the installation, as well as to protection and prevention measures
Enforcement of applicable regulations and of the terms of license	Oversight with regard to legality and expediency* Checking of consolidated findings with regard to their relevance to standard national requirements	Implementation of necessary measures to avert hazards, concerning necessary safety improvements and concerning improvements of protection and prevention measures
Secondary functions		
Regulatory safety research	Investigation of safety issues for standard requirements	Plant-specific studies
Monitoring of events, operating experience and implementation	Examination and assessment of events in Germany and abroad, with regard to generic relevance to the safety of installations as well as to protection and prevention measures; national organisation of experience feedback	Examination and assessment of events with regard to relevance to the safety of installations as well as to protection and prevention measures
Radiation protection, environmental monitoring	Monitoring of the radiation exposure of the population and the federal territory	Plant-specific monitoring of emissions and immissions (radiation exposure of workers and in the environment)
Emergency preparedness	Preparation and planning of general requirements; cross-national emergency preparedness, international reporting systems	Participation in the preparation and planning of general requirements Plant-specific emergency protection
International co-operation	Participation in international activities to determine the state of the art in science and technology and regarding nuclear regulations, and provision for national purposes; Fulfilment of international obligations; assertion of German safety interests	Consideration of the internationally documented state of the art in science and technology Participation in co-operation with neighbouring countries in the case of installations close to the border, especially on the basis of bilateral agreements

Grey	Leading function, execution within area of competence
Light grey	Function with separate competences but common objectives
White	"Federalism function" oversight with regard to legality and expediency or participation (e.g. in the *Länder* Committee for Nuclear Energy (LAA), by provision of information)

* This also means that the Federal Government may execute its power to decide the respective matter in hand itself, and initiate on its own authority the corresponding detailed examinations.

Source: Country Information [5].

3.1.2. Licensing process

A license is required for construction, operation, and essential modification of such an installation, or for the operation and decommissioning of a stationary installation for the production, treatment, processing or fission of nuclear fuel. Pursuant to the Atomic Energy Act, licenses for the construction of nuclear power plants for the commercial production of electricity are no longer issued. Licensing procedures are therefore only performed for the modification of existing nuclear installations and for decommissioning.

The operating licenses for existing nuclear power plants are not limited in time and thus do not require renewal. The authorisation for power operation of existing nuclear power plants expires once the shutdown dates fixed in the Atomic Energy Act are reached or if the electricity volume for the respective plant, as stipulated in the Atomic Energy Act, or the electricity volume derived from transfers has been produced.

The actual details and procedure of licensing are specified in the Nuclear Licensing Procedure Ordinance. Here, the application procedure, the submission of supporting documents and the participation of the general public are described. Furthermore, the Nuclear Licensing Procedure Ordinance specifies the assessment of any environmental impact and the consideration of other licensing requirements (e.g. regarding the possible release or discharge of non-radioactive pollutants into air or water).

The written license application is submitted to the competent licensing authority of the *Land* in which the nuclear installation is sited. On the basis of the submitted documents, the licensing authority examines whether or not the licensing prerequisites have been met. All federal, *Länder*, local and other regional authorities – according to circumstances also authorities of other states - whose jurisdiction is involved shall take part in the licensing procedure. These are e.g. authorities responsible under the building code, the water code, for regional planning and for disaster control. Participation of the public was obligatory for construction licenses. In case of major modifications, the authority may waive a public participation if the modification does not give rise to the concern that there might be adverse effects on the public. However, the public has to be involved if this is required pursuant to the Act on the Assessment of Environmental Impacts. The competent authority performs a final evaluation of the environmental impacts on the basis of the requirements in nuclear and radiation protection regulations. The final decision of the licensing authority is based on the entirety of application documents, evaluation reports by the authorized experts and, if available, the statement by the BMU and the authorities involved as well as the findings from objections raised in the public hearing.

As in licensing, the prime objective of the regulatory supervision of nuclear installations is to protect the general public and workers in these installations against the hazards connected with the operation of the installation. Nuclear installations are subject to continuous regulatory supervision over their entire lifetime - from the start of construction to the end of decommissioning. Supervision is performed by the *Länder* authorities, on behalf of the Federal Government. Authorized experts called in by the supervisory authority have access to the nuclear installation at any time and are authorized to perform the necessary examinations and to demand pertinent information. In addition, the operators of NPPs have to supply operating reports to the supervisory authorities at regular intervals. Any events that are relevant to safety and to physical protection must be reported to the authorities. In addition to the continuous regulatory supervision, comprehensive periodic safety reviews are to be performed every ten years.

Pursuant to the Atomic Energy Act, the Nuclear Financial Security Ordinance regulates that sufficient financial security for covering possible claims for damage compensation is provided. The Paris Convention on Third Party Liability in the Field of Nuclear Energy, amended by the Brussels Supplementary Convention, is taken into account. For damages due to a nuclear event caused by a nuclear installation, the operator generally has unlimited liability. In order to fulfil the obligation to pay any damages, the operator has to provide financial security which may amount to € 2.5 billion. This financial security may be ensured by liability insurance or other financial means, e.g. private warranty. The Federation carries an additional indemnity of up to € 2.5 billion which may be claimed by the damaged party.

The individual power utilities or their subsidiaries are the licensees of the NPPs. They are obliged by law to build up financial reserves to be prepared for the follow-up costs connected with the operation of a nuclear power plant, such as the decommissioning and dismantling of the installations, and the treatment and disposal of radioactive material including spent fuel. The financial reserves are adjusted on an annual basis. The valuation of these reserves is regularly reviewed by independent accountants and the financial authorities. The responsibility for the disposal of radioactive waste lies with the Federation. All other radioactive waste management facilities, i.e. spent fuel interim storage, are within the responsibility of the waste producers. The *Länder* have to construct and operate regional state collecting facilities for the interim storage of radioactive waste originating, in particular, from radioactive applications in medicine, industry, or universities. The protection objective of disposal of radioactive waste in a repository is laid down in the Atomic Energy Act and the Radiation Protection Ordinance. The Federal Mining Act regulates aspects concerning the operation of a disposal mine. The Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste (as of September 2010) specify the measures to be taken in order to achieve the protection objective. In addition, environmental legislation must be taken into account. In particular, an environmental impact assessment has to be performed.

For further information see [5] and [8].

3.2. Main national laws and regulations in nuclear power

See Handbook on Nuclear Safety and Radiation Protection

The Atomic Energy Act is the core of national regulations with respect to nuclear safety and waste management in Germany. It was promulgated on 23 December 1959. Since then, it has been amended several times. Since the amendment of 2002, the purpose of the Atomic Energy Act is to end the use of nuclear energy for the commercial production of electricity in a structured manner, and to ensure on-going operation up until the date of discontinuation. It also aims to protect life, health and property against the hazards of nuclear energy and the detrimental effects of ionizing radiation and, furthermore, to provide for the compensation for any damage and injuries incurred. Most of the regulations laid down in the Atomic Energy Act are not exhaustive and are further specified, both regarding the procedures and the substantive legal requirements, by ordinances, general administrative provisions and regulatory guidance instruments. The concrete rules concerning the safety of nuclear power plants are in particular comprised of the safety standards of the Nuclear Safety Standards Commission (*Kerntechnischer Ausschuss* - KTA), recommendations from the Reactor Safety Commission (*Reaktor-Sicherheitskommission* - RSK), the Nuclear Waste Management Commission (*Entsorgungskommission* – ESK) and the Commission on Radiological Protection (*Strahlenschutzkommission* - SSK) but also conventional technical standards (DIN, ISO and IEC).

Main national laws and regulations on nuclear power and waste management

See chapter 1A of the Handbook on Nuclear Safety and Radiation Protection

- Atomic Energy Act (*Atomgesetz*)
- Precautionary Radiation Protection Act *(Strahlenschutzvorsorgegesetz)*
- Radiation Protection Ordinance *(Strahlenschutzverordnung)*
- Nuclear Licensing Procedure Ordinance *(Atomrechtliche Verfahrensverordnung)*
- Nuclear Financial Security Ordinance *(Atomrechtliche Deckungsvorsorge-Verordnung)*
- Repository Prepayment Ordinance *(Endlagervorausleistungsverordnung)*
- Nuclear Reliability Assessment Ordinance *(Atomrechtliche Zuverlässigkeitsüberprüfungs-Verordnung)*
- Nuclear Safety Officer and Reporting Ordinance *(Atomrechtliche Sicherheitsbeauftragten- und Meldeverordnung)*
- Nuclear Waste Shipment Ordinance *(Atomrechtliche Abfallverbringungsverordnung)*

References

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[3] Bundesministerium für Wirtschaft und Technologie, http://www.bmwi.bund.de

[4] Arbeitsgemeinschaft Energiebilanzen, http://www.ag-energiebilanzen.de

[5] Report under the Convention on Nuclear Safety by the Government of the Federal Republic of Germany for the Fifth Review Meeting in April 2011, http://www.bmu.de/english/nuclear_safety/downloads/doc/6418.php

[6] State and Development of Nuclear Energy Utilization in the Federal Republic of Germany 2010 (BfS-SK-17/11), http://nbn-resolving.de/urn:nbn:de:0221-201108016010
[7] Energy Policies of IEA Countries, Germany 2007 Review, OECD/IAEA 2007
[8] Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management - Report of the Federal Republic of Germany for the Fourth Review Meeting in May 2012, http://www.bmu.de/english/nuclear_safety/downloads/doc/47894.php

Appendix 1: International, Multilateral and Bilateral Agreements

AGREEMENTS WITH THE IAEA

• NPT related safeguards agreement EURATOM/IAEA, INFCIRC/193	Entry into force for Germany:	21 February 1977
• Protocol Additional to the Euratom Agreement, INFCIRC/193(GOV/1998/28)	Signed:	22 September 1998
• Improved procedures for designation of safeguards	Proposal rejected by EURATOM but special procedures agreed upon	16 February 1989
• Agreement on privileges and immunities, INFCIRC/9	Entry into force for Germany:	4 August 1960

MULTILATERAL SAFEGUARDS AGREEMENTS

• Brazil/Germany/IAEA, INFCIRC/237	Entry into force:	26 February 1976
• application suspended, INFCIRC/237/Add.1	Entry into force:	21 October 1999
• Spain/Germany/IAEA, INFCIRC/305	Entry into force:	29 September 1982

OTHER RELEVANT INTERNATIONAL TREATIES

• Treaty on the Non-Proliferation of Nuclear Weapons - NPT, INFCIRC/140	Entry into force for Germany:	2 May 1975
• Convention on the Physical Protection of Nuclear Material, INFCIRC/274	Entry into force for Germany:	6 October 1991
• Amendment to the Convention on the Physical Protection of Nuclear Material	Signed:	8 July 2005
• Convention on Early Notification of a Nuclear Accident, INFCIRC/335	Entry into force for Germany:	15 October 1989
• Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, INFCIRC/336	Entry into force for Germany:	15 October 1989
• Paris Convention on Third Party Liability in the Field of Nuclear Energy	Entry into force for Germany:	30 September 1975
• Brussels Supplementary Convention	Entry into force for Germany	1 January 1976

• Joint Protocol Relating to the Application of the Vienna and Paris conventions, INFCIRC/402	Entry into force for Germany:	13 September 2001
• Vienna Convention on Civil Liability for Nuclear Damage, INFCIRC/500		Not signed
• Convention on Supplementary Compensation for Nuclear Damage, INFCIRC/567		Not signed
• Convention Relating to Civil Liability in Maritime Carriage of Nuclear Materials	Entry into force for Germany:	30 December 1975
• Convention on Nuclear Safety, INFCIRC/449	Entry into force for Germany:	20 April 1997
• Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, INFCIRC /546	Entry into force for Germany:	18 June 2001
• International Convention for the Suppression of Acts of Nuclear Terrorism	Entry into force for Germany:	9 March 2008
• ESPOO Convention	Entry into force for Germany:	6 November 2002
• Aarhus Convention	Entry into force for Germany:	15 April 2007
• European Atomic Energy Community (EURATOM)		Member
• ZANGGER Committee		Member
• Nuclear Suppliers Group		Member

BILATERAL AGREEMENTS CONCERNING THE SAFETY OF NUCLEAR INSTALLATIONS AND RADIATION PROTECTION

With the following 59 countries, Germany concluded in total 182 bilateral agreements on the safety of nuclear installation or radiation protection:

Argentina, Armenia, Australia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Brazil, Bulgaria, Canada, Chile, China, Croatia, Czech Republic, Denmark, Egypt, Finland, France, Georgia, Greece, Hungary, India, Indonesia, Iran, Iraq, Japan, Kazakhstan, South Korea, Kuwait, Kyrgyzstan, Lithuania, Luxembourg, Macedonia, Mexico, Moldova, Mongolia, the Netherlands, New Zealand, Norway, Pakistan, Poland, Portugal, Romania, Russian Federation, Saudi Arabia, Serbia and Montenegro, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Tajikistan, Ukraine, United Kingdom, USA, Uzbekistan

For further information see Bilateral Agreements in chapter 1D of the Handbook on Nuclear Safety and Radiation Protection.

Appendix 2: DIRECTORY OF THE MAIN ORGANIZATIONS, INSTITUTIONS AND COMPANIES INVOLVED IN NUCLEAR POWER RELATED ACTIVITIES

NATIONAL ATOMIC ENERGY AUTHORITIES, FEDERATION AND LÄNDER

Bundesministerium für Wirtschaft und Technologie (BMWi)	Berlin	http://www.bmwi.de
Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)	Berlin	http://www.bmu.de
Bundesministerium für Bildung und Forschung (BMBF)	Berlin	http://www.bmbf.de
Bundesamt für Strahlenschutz (BfS)	Salzgitter	http://www.bfs.de
Innenministerium Baden-Württemberg	Stuttgart	http://www.innenministerium.baden-wuerttemberg.de/
Ministerium für Wirtschaft und Finanzen Baden-Württemberg	Stuttgart	http://www.mfw.baden-wuerttemberg.de/sixcms/detail.php/62315
Ministerium für Umwelt, Klima und Energiewirtschaft Baden-Württemberg	Stuttgart	http://www.um.baden-wuerttemberg.de
Bayerisches Staatsministerium für Wirtschaft, Infrastruktur, Verkehr und Technologie	München	http://www.stmwivt.bayern.de
Bayerisches Staatsministerium für Umwelt und Gesundheit	München	http://www.stmugv.bayern.de
Hessisches Ministerium für Umwelt, Energie, Landwirtschaft und Verbraucherschutz	Wiesbaden	http://www.hmulv.hessen.de
Niedersächsisches Ministerium für Umwelt und Klimaschutz	Hannover	http://www.mu.niedersachsen.de
Ministerium für Justiz, Gleichstellung und Integration Schleswig-Holstein	Kiel	http://www.schleswig-holstein.de/MJGI/DE/ReaktorsicherheitStrahlenschutz/ReaktorsicherheitStrahlenschutz_node.html

MAIN POWER UTILITIES

EnBW Energie Baden-Württemberg AG	Karlsruhe	http://www.enbw.com
E.ON Kernkraft GmbH	Hannover	http://www.eon-kernkraft.com
RWE Energie AG	Essen	http://www.rwe.com
Vattenfall Europe AG	Berlin	http://www.vattenfall.de/

MANUFACTURER, SERVICES AND OTHER NUCLEAR ORGANIZATIONS

ANF - Advanced Nuclear Fuels GmbH	Lingen	http://www.areva.com/EN/operations-924/anf-lingen-production-of-components-for-fuel-assemblies.html
Arbeitsgemeinschaft Versuchsreaktor GmbH (AVR)	Jülich	http://www.ewn-gmbh.de/ewngruppe/avr/the-company/company-profile.html?L=1%2F

AREVA NP (Germany) GmbH	Erlangen	http://de.areva.com/
Brenk-Systemplanung	Aachen	http://www.brenk.com/system/haupt.htm
Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)	Hannover	http://www.bgr.bund.de
Bundesverband der Energie- und Wasserwirtschaft e.V. (BDEW)	Berlin	http://www.bdew.de/internet.nsf/id/DE_Home
Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe (DBE)	Peine	http://www.dbe.de
Deutsche Kernreaktor-Versicherungsgemeinschaft (DVKG)	50950 Köln	Postfach 52 01 29
Deutsches Atomforum (DAtF) e.V. Kerntechnische Gesellschaft (KTG) e.V. Informationskreis Kernenergie (IK) INFORUM Verlag- und Verwaltungsgesellschaft mbH	Berlin	http://www.kernenergie.de/kernenergie/
Deutsch-Schweizerischer Fachverband für Strahlenschutz e.V.	Garching	http://www.fs-ev.de
Energiewerke Nord GmbH (EWN)	Greifswald	http://www.ewn-gmbh.de/ewngruppe/ewn/standort-greifswald/das-unternehmen/firmenportraet-aufgabe.html
Entsorgungskommission (ESK)	Bonn	http://www.entsorgungskommission.de/default.htm
Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH	Köln	http://www.grs.de
Gesellschaft für Nuklear-Service (GNS)	Essen	http://www.gns.de
Internationale Länderkommission Kerntechnik (ILK)		http://www.stmug.bayern.de/umwelt/reaktorsicherheit/ilk/index.htm
Kerntechnischer Ausschuß (KTA)	Salzgitter	http://www.kta-gs.de
Kerntechnische Hilfsdienst GmbH (KHG)	Eggenstein-Leopoldshafen	http://www.khgmbh.de
Kraftanlagen Heidelberg GmbH	Heidelberg	http://www.ka-heidelberg.de
KSB	Frankenthal	http://www.ksb.com/ksb-de/
Physikalisch-Technische Bundesanstalt (PTB)	Braunschweig	http://www.ptb.de
Reaktor-Sicherheitskommission (RSK)	Bonn	http://www.rskonline.de
NUKEM GmbH	Alzenau	http://www.nukem.de
Siemens AG, Power Generation	Erlangen	http://www.powergeneration.siemens.com
Siempelkamp Nukleartechnik GmbH	Krefeld	http://www.siempelkamp.com
Simulatorzentrum KSG - Kraftwerksimulator-Gesellschaft mbH GfS - Gesellschaft für Simulatorforschung mbH	Essen	http://www.simulatorzentrum.de
Strahlenschutzkommission (SSK)	Bonn	http://www.ssk.de
Studsvik GmbH & Co. KG	Pforzheim	http://www.studsvik.com/
TÜV Nord Gruppe	Hannover	http://www.tuev-nord.de
TÜV Süd Gruppe	München	http://www.tuev-sued.de
Urenco Deutschland GmbH	Gronau	http://www.urenco.com
Vereinigung der Großkraftwerksbetreiber (VGB)	Essen	http://www.vgb.org
Westinghouse Electric Company		http://www.westinghousenuclear.com

Wiederaufarbeitungsanlage Karlsruhe Rückbau- und Entsorgungs-GmbH	Karslruhe	http://www.ewn-gmbh.de/ewngruppe/wak/das-unternehmen/firmenportraet-aufgaben.html
Wismut GmbH	Chemnitz	http://www.wismut.de

NUCLEAR RESEARCH INSTITUTES

Deutsches Elektronen-Synchrotron (DESY)	Hamburg	http://www.desy.de/
Fachgruppe Energietechnik an der Hochschule Zittau/Görlitz	Zittau/Görlitz	http://f-m.hszg.de/fakultaet/fachgruppe-energietechnik.html
Forschungszentrum Jülich GmbH	Jülich	http://www.fz-juelich.de/portal/
Helmholtz-Zentrum Dresden-Rossendorf e.V.(HZDR)	Dresden	http://www.hzdr.de
Helmholtzzentrum für Schwerionenforschung GmbH (GSI)	Darmstadt	http://www.gsi.de/
Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)	Berlin	http://www.helmholtz-berlin.de/
Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung GmbH	Geesthacht	http://www.gkss.de/index.html.de
Institut für Kernenergetik und Energiesysteme (IKE) an der Universität Stuttgart	Stuttgart	http://www.ike.uni-stuttgart.de/
Karlsruher Institut für Technologie (KIT)	Karlsruhe	http://www.kit.edu/
Max-Planck-Institut für Kernphysik	Heidelberg	http://www.mpi-hd.mpg.de/
Institut für Energietechnik der Technischen Universität Dresden	Dresden	http://tu-dresden.de/die_tu_dresden/fakultaeten/fakultaet_maschinenwesen/iet
Verein für Kernverfahrenstechnik und Analytik Rossendorf e.V.	Dresden	http://www.vkta.de/de/index.html

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