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Short Country Report

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DIALOGIK

EHU Europos humanitarinis universitetas

TU/e Technische Universiteit Eindhoven University of Technology Where innovation starts

Friedrich-Schiller-Universität Jena

Swedish Defence University

GRE

KTH

LUT Lappeenranta University of Technology

upna Universidad Pública de Navarra

UPMC Sorbonne Universités

The University Of Sheffield.

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Executive summary

This country report explores the history of the relations between nuclear energy and society in the Federal Republic of Germany (FRG, West Germany). It belongs to a collection of 20 short country reports on the History of Nuclear Energy and Society (HoNESt, project Ref.662268) that tackle the complex sociotechnical system around nuclear energy. Nuclear energy is intertwined with developments in social, economic, environmental, political, and cultural spheres. Moreover, it represents a globalized system involving transnational transfers of knowledge, materials, technologies, people, and products including electrical power, medical elements, toxic wastes, and other environmental hazards, materials, capacities, and knowledge that must be carefully safeguarded. For instance, transfer of knowledge and ideas needs mediators like experts, politicians, activists, organizations, and the media to convey this knowledge from one context to another. Therefore, nuclear energy is a complex social and technological phenomenon that influences societies but is also shaped by societies. This short country report is designed to assemble information and research results on the history of the relations between nuclear energy and society in West Germany in an accessible manner, and to document the findings with references. The purpose of this country report is threefold:

1. It provides basic elements of narrative and analysis for further historical research.
2. It provides information, context, and background for further analysis for HoNESt's social science researchers.
3. It provides accessible information on nuclear-societal relations in West Germany for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policymakers, journalists).

West Germany's Nuclear History in Brief

In the 1950s and the beginning of the 1960s, when the United States had launched the Atoms for Peace program and the first nuclear power plant went online in Germany, nuclear power seemed to be a modern solution to humankind's energy problems. Just over a year after the federal government had adopted the Atomic Energy Act in 1959 on the peaceful utilization of atomic energy and the protection against its hazards, the first nuclear power plant went online at

the border of Hesse and Bavaria. With it, nuclear power in West Germany started as an industrial business. In the 1960s a phase of development and planning followed that was hardly noticed by the public. The first commercial nuclear reactor went on the grid in 1961, but it took many government incentives to convince energy companies to switch to nuclear power completely. The planning and building of nuclear power plants, radioactive waste disposal facilities, or reprocessing plants in the federal states of Baden-Württemberg (Wyhl), Schleswig-Holstein (Brokdorf), Lower Saxony (Gorleben), North Rhine-Westphalia (Kalkar), and Bavaria (Wackersdorf) provoked massive and recurring protests throughout the 1970s and 1980s. The protests against the construction of the plant in Wyhl (Kaiserstuhl) on the French border in Germany's southwest, gave power to the nascent environmental movement when—in 1975—30,000 people demonstrated, occupying the site and developing protest structures. The Chernobyl nuclear power plant catastrophe in April 1986 led to an upswing of intensified debates in Germany and also gave rise to the Mothers against Chernobyl movement. As a result, a Ministry for the Environment was founded at the federal level and citizens' initiatives—many initiated and run by women—sprang up in high numbers. In 1998, the red-green coalition agreement decided to phase out nuclear energy within 20 years. Two years later, the federal government and electric supply companies signed an agreement about the future operation of German nuclear power plants. After tsunami and partial meltdown at the Japanese nuclear power plant Fukushima Daiichi in 2011, the topic received renewed attention with continued protests. Chancellor Angela Merkel announced the shutdown of all German power plants by 2022 with eight of the 17 operating German reactors shut down immediately. Until March 2011, these 17 reactors produced 25 percent of the country's electricity. In 2016, the remaining eight reactors produced 16 percent, while half of Germany's electricity was generated from coal.

1. Historical Context (narrative)

1.1. Introduction to the historical context

Concerns about nuclear power were publicly expressed for the first time in the 1950s and 1960s and focused on the high costs, unproven technology, and dangers of nuclear waste disposals (Rudig 1990, 63). In later decades, activists criticized the federal government because they perceived the politics in which it pursued its big-industry projects as nontransparent and authoritarian (Glaser 2012, 12), and loyal state citizens often had experiences that turned their trust into scepticism. Large parts of the population frequently mistrusted both the state and the energy industry, and faith in the problem-solving strategies of experts and academics faded. Moreover, low-level radiation, catastrophic disasters, disposal of radioactive waste, and other environmental impacts were criticized (Schils 2011, 4), alongside a more general critique of large-scale technology. Finally, opponents doubted that there were issues with alternative sources of energy and disapproved of the lack of the political will to actually invest in it (Hubert 2012). The societal controversy over nuclear energy that had already begun in the 1950s has been interpreted as a true success story of Germany's social and political culture (Radkau 1987; Weitze and Trischler 2006). The controversy was carried out at all societal levels and integrated not only small groups of experts and stakeholders, but numerous intermediary social groups and actors.

1.2. Contextual narrative

On 7 May 1946, the Allied Control Council Law No. 25 came into force. With this law, the Control Council strictly forbade West Germany any strand of research that had civil and military applications, which included nuclear physics (Müller 1990, vol. 1., 44). Yet, the West German chancellor Konrad Adenauer and his government did not want to be excluded from international developments and were not inclined to accept Allied restrictions in this field. After the ratification of the General Treaty (also: Germany Treaty) in 1952, which regulated the relationship between the Federal Republic of Germany and the Western Allies (France, Great Britain, and the USA), Chancellor Adenauer and the physicist Werner Heisenberg publicly pushed for the construction of a nuclear reactor. To connect to international developments, an organizational frame was

necessary. To this end, Adenauer initiated the building of a body that was to prepare the nuclear energy industry. The ratification of the Bonn–Paris conventions in 1955 put an end to the Allied occupation of West Germany and freed the way for the civilian use of nuclear energy (Tiggemann 2010, 47 et seq.). The primary goal of the West German government was now to reduce the research backlog of more than a decade and to found structures to support nuclear energy. In the same year, the West German government decided to convene the German Nuclear Commission—though it was not responsible to the parliament, it functioned as an advisory body to the Atomic Minister (Gleitsmann 1987, 34 and 38). A driving motif to promote nuclear energy was the pronuclear, euphoric atmosphere in West Germany, but it was accompanied by a fear of possible energy shortages in the future, after the Technical University in Karlsruhe had predicted a coal shortage for the mid-1970s (Radkau 1983, 113).

The euphoric atmosphere in West Germany was partly inspired by the first international conference on the Peaceful Uses of Atomic Energy organized in 1955 in Geneva under the leadership of the United Nations. The Federal Republic undertook steps for international cooperation and was amongst the founding members of the European Atomic Energy Community (also known as Euratom) in 1957 (Stamm 1992, 39 et seq.). Finally, it created the legal basis for the construction and operation of nuclear power plants in Germany: in 1959 the federal government adopted the Atomic Energy Act on the peaceful utilization of atomic energy and protection against its hazards (Atomic Energy Act 1959, 814). In the same year, the German Atomic Forum was created. Following the US American model, it became the representative for the private sector and the public for the support of nuclear energy (Müller 1990, vol. 1, 198 et seq.). In 1961, the forum opened up for interested organizations, companies, and associations. In the same year, the first nuclear power plant went online between Karlstein and Kahl at the border of Hesse and Bavaria, which heralded the start of nuclear power in West Germany as an industrial business. Soon German politicians spoke about a future that would solve all distribution problems through cheap atomic energy. A phase of development and planning followed which went nearly unnoticed by the public. Physicist and Nobel laureate Werner Heisenberg in particular became a driving force of the nuclear sector. For him, a powerful nuclear industry was crucial to the overall economic competitiveness of

West Germany, and he understood the forceful development of nuclear research centers as a necessary first step in that direction.

His vision of building up a strong federal atomic program, however, remained contested, along with the question of siting nuclear research facilities. Energy companies like Rheinisch-Westfälisches Elektrizitätswerk AG *(*RWE Power AG) or PreußenElektra, which paid for and operated the nuclear reactors, were especially critical of nuclear power because of the costs and the technical uncertainties involved. For instance, their relatively new facilities for producing brown coal would have been shut down if they had changed to nuclear energy—something RWE firmly rejected (Tiggemann 2010, 62). They were reluctant to adopt a new and unproven technology and pleaded instead for renewable energy. As a result, Franz-Josef Strauß's successor in the Atomic Ministry, Siegfried Balke, saw energy supply companies as opponents to his politics. He tried to use energy politics against the energy industry, for instance by keeping them out of the planning for the first atomic program (Radkau 1983, 116 et seq.). Until the end of the 1960s, RWE clearly gave preference to brown coal over nuclear energy. In 1968 the energy supply company staged a turnaround and took the lead in the German development of the nuclear industry by placing the order for Biblis A. Historians described the project as having set new standards in power plant construction worldwide (Tiggemann 2010, 63 and 176). The plant was built in the South Hessian municipality of Biblis and consisted of two units: unit A, with a gross output of 1,200 megawatts, and unit B, with a gross output of 1,300 megawatts. The pressurized water reactor Biblis A began operating in 1974. After the nuclear catastrophe in Fukushima in 2011, bloc A was shut down; however, bloc B was already in a scheduled revision and therefore did not have to be closed down.

In an effort to make a case against critics of the nuclear energy industry, the German government established major research centers in Karlsruhe and Jülich in 1956 and 1962 that soon became influential in European nuclear research and development. The plan to promote research to generate arguments against critics of nuclear energy worked only in part. This time, opposition came from civil society, especially women. Local women's associations in Karlsruhe were critical of the research centers because of the danger posed to citizens in a city with a high population density. The city of Karlsruhe had commissioned a survey that revealed that only 27

percent of interviewed women approved of the research centers, compared with 63 percent of interviewed men (Renn 1995, 762). The civilian and military use of nuclear power was a topic that frequently divided the sexes on the issue of quality of life. Green politician Petra Kelly expressed the opposing views of men and women on the military use of nuclear energy as follows: “[n]uclear war and war in general [is] a manifestation of the constant war between masculine and feminine values” (Women should push, 1984).

Not only women opposed research centers and nuclear sites— the 1950s was generally the time of the first protest wave in Germany. When the German government planned to equip the German army with so-called tactical nuclear warheads and launch sites for short-range missiles, 18 German nuclear scientists—including Nobel laureates Heisenberg, Max Born, Otto Hahn, Max von Laue, and Wolfgang Paul—opposed this with the Göttingen Manifesto of 12 April 1957. The proclamation pointed at the destructive power of these weapons and warned of the military and political consequences of nuclearization (Schirrmacher 2007; Lorenz 2011). The Campaign against Atomic Death formed in response to fear of the atomic armament of the German army and led to scepticism towards civilian nuclear facilities as well (Milder 2017). The decade also saw the foundation of critical nuclear energy non-governmental organizations, some of which were politically contested. One example was the “World Union for Protection of Life” (WSL), which became active in over 30 countries. The association was founded in 1960 by the Austrian writer, environmentalist, and former Nazi party member, Günther Schwab. Membership grew rapidly and from 1970 onwards, the WSL was an influential power in the growing ecology movement. For instance, the German WSL was one of the founding members of the “Bundesverband Bürgerinitiativen Umweltschutz,” which is the umbrella organization of all environmentally active citizens’ initiatives in Germany. Due to its partly right wing activities and members, the German WSL branch was banned from the international association in 1985 and dissolved in 2001 (Kirchhof 2011, 36 and 41; Engels 2006, 78 and 332). These first protests differed from later ones because protestors did not take direct democratic measures or cooperate transnationally.

These steps were taken for the first time in the mid-1970s with the protest against a power plant in the Badensian village of Wyhl. The actions are widely recognized as the starting point of the

anti-nuclear movement in Germany and historians have interpreted them as a national site of memory deeply embedded in German culture (Rusinek 2003). Though—as explained above—this protest was not the first one, it did become an example to activists for later protests.

In 1973, Wyhl was chosen as the site for a nuclear power plant, which caused direct opposition. In the following two years, signatures and appeals against the construction of the nuclear power plant were submitted to the Mminister of the Interior. When these actions did not affect the political decision, local people—who were transnationally supported—increased their opposition and occupied the construction site. In 1975, it was decided that construction should be interrupted, but the decision was reversed and the site in Wyhl was occupied once more. In March 1977, the administrative court withdrew the construction license for the plant but later initiated a process of second instance. In 1982, the Minister-President of Baden-Württemberg declared the construction of the nuclear power plant in Wyhl unnecessary and confirmed his decision five years later. In the end, the plant was never built (Engels 2003, 350 et seq.; Tiggemann 2010, 212 et seq.).

A few other projects played particularly critical roles in the public debate in West Germany. The (planned) building of reactors in Brokdorf, Kalkar, Wackersdorf, and Gorleben caused a further shift from optimism to pessimism over nuclear energy and triggered massive protests as well as violent disputes between activists and police. In 1975, 25,000 people took to the streets in Wyhl; in 1977, 40,000–60,000 people demonstrated at the site at Kalkar; and two years later, in 1979, 100,000 people joined the Gorleben track protest. Up until then, the rallies against nuclear facilities had been the biggest in West Germany's protest history (Mende 2011, 332).

Concerns about a light-water nuclear power reactor proposal at Brokdorf, near Hamburg, had become a public issue in November 1973 (the plans for it dated back to the late 1960s). But it was not until 1976 and 1977—during the first construction phase—that opponents started to protest violently against it. The police had learned from their experience at Wyhl and wanted to avoid similar incidents at all costs. Shortly after receiving the permit for building the reactor, the police cordoned off the Brokdorf site. That night saw violent clashes between opponents and the police and, a few weeks later, 30,000 people demonstrated against the project. This led to a halt in construction that was justified by the lack of a disposal strategy for spent fuel. In 1981,

construction continued and about 100,000 people demonstrated, causing a severe confrontation with police once again. More conflicts with the police followed in 1986, the year the Brokdorf nuclear power reactor eventually started operating (document, Glaser 2012, 12 et seq.).

In 1985 the Deutsche Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen mbH (German waste disposal company DWK) decided to build and operate a reprocessing plant in Wackersdorf, a municipality in the district of Schwandorf in Bavaria, Germany. When they started clearing the woodland, 30,000 people demonstrated, occupied the building site, and erected a hut village. After the Chernobyl nuclear power plant catastrophe in April 1986, the violent dispute between police and anti-nuclear activists reached its peak. A large number of initiatives—many organized and run by women—mushroomed, such as the group “Mothers against Nuclear Power,” which took part in hearings against Wackersdorf (Blomeyer and Wurzbacher 2016; Wurzbacher 1988; Mütter 1988). Finally, the protesters were successful: the energy company Vereinigte Elektrizitäts und Bergwerks Aktiengesellschaft (United Electricity and Mining Corporation, VEBA) changed its politics and was no longer interested in the reprocessing plant, resulting in a building freeze in 1988.

The building of a radioactive waste disposal facility in Gorleben, Lower Saxony, which was planned as a future deep final repository for waste from nuclear reactors, also provoked massive protests. The decision to use Gorleben as site for storing nuclear waste came in 1977 under Chancellor Helmut Schmidt (SPD) and Prime Minister Ernst Albrecht (CDU, conservatives). Before the decision was made, over one hundred salt domes had been considered. Most important were the geopolitical criteria, such as the sparse settlement at the border area close to East Germany. Protest against the decision arose early on and the site was given up as a final repository. Today the plant serves as an intermediate storage facility for waste from Germany's nuclear power plants, which is reprocessed in France and then sent back to Germany for final storage. Current protests against nuclear energy in Gorleben are directed at the annual transport of dry cask containers from France to Germany and continue to demand a huge police presence (Glaser 2012, 15; Khoo and Rau 2012, 156).

An interesting technological project that failed and later became an enterprise of the burgeoning leisure sector was the construction of SNR-300, a pilot-scale fast breeder reactor, in Kalkar. The

project started in 1972 as an international collaboration. Built to produce 327 megawatts of electricity for the Rhineland, SNR-300 was a solution to limited uranium reserves in the Federal Republic and a means to become independent from energy imports in the near future. Criticism soon arose about the safety of the breeder and international demonstrations took place in 1974 and 1977. Experts expressed their concerns about the reactor coolant as well as the controlling process, and a four-year halt in construction was agreed upon. Even after the construction of SNR-300 was completed in 1985, the government of North Rhine-Westphalia did not authorize use of the building because of unforeseeable risks in operating the reactor. The shutdown of the project was announced in 1991, and the unused machines and facilities were transferred to reactors and production complexes in other countries. Finally, the reactor was sold and turned into an amusement park.

The transition from optimism to pessimism manifested in Germany's political landscape too. While the Social Democratic Party (SPD) strongly advocated nuclear energy as a trigger for technological and industrial modernization during the 1950s and 1960s, it switched sides and became a critic of nuclear energy in the 1970s. In 1998—under the newly elected Social Democratic Party (SPD) Chancellor Gerhard Schröder—the red-green coalition decided to phase out nuclear energy within 20 years. The Christian Democratic Union (CDU) and Free Democratic Party (The Liberals, FDP) coalition government that was elected in September 2009 was committed to rescinding the phase-out policy. Yet, after the Fukushima Daiichi nuclear disaster in 2011, Chancellor Angela Merkel announced the closedown of all German power plants by 2022. Parliament and most German politicians approved of the moratorium.

Women were often at the forefront among critical citizens and since the 1970s they had raised their voices louder than ever. Many of them argued that there was an essential connection between the suppression of women in a patriarchal society and the subjugation of nature, resulting in its damage. They pointed out that humans are no longer an integral part of the environment and claimed a new concept of nature focusing on intuition, emotionality, and spirituality (Thiessen 2010, 37–44). The Protestant theologian, political scientist, and colleague of Petra Kelly, Eva Quistorp, was one of the first women to talk publicly about this ecofeminist theory when she gave a presentation entitled "Women and Mothers against the Destruction of

the Natural World" at the Free University of Berlin in 1976 (Quistorp 1979, 152). Within the ecofeminism school of thought, positions based on difference feminism theory emerged, elevating gender differences to a defining category. The theories implied differences between men and women with regard to their biological and social gender but claimed the principle equality between genders. This newly formulated political trend within the broader feminist movement presented female qualities as non-deficient and aimed at putting an end to the perception that women were an aberration from the male norm. It created a positive reference to shared femaleness and became a source of emotional strength and legitimization for political activities in the women's peace movement of the 1980s (Flaake 2005, 158–175). In particular, the Chernobyl nuclear power plant catastrophe in April 1986 led to an upswing of intensified debates in Germany. Women highlighted the differences between the sexes and founded new initiatives, informed themselves and others about the risks involved in the civilian and military use of nuclear power, published leaflets, gave speeches, and organized conferences. One example was the international congress "Women and Ecology: Against the Feasibility Delusion" that took place in Cologne in October 1986 and was organized by feminists in the local area, by the Greens, and by the autonomous women's movement (Lenz 2010, 855).

Historiography has given various reasons why the opposition against nuclear power was generally strong in Germany and also violent at times. Historians found answers in Germany's national socialist past, which might have resulted in a strong scepticism towards the authorities as well as a lack of religious influences in the movement, as can be found in the United States. Others emphasize society's criticism of cost-benefit analyses. First, nuclear opponents feared future generations' accusations that their ancestors had failed to act against the atomic industry and had become its accomplices instead; children and grandchildren had made similar arguments regarding the country's national socialist past. Those who did not wish to be seen as traitors and followers had a duty to oppose nuclear power. Additionally, large parts of the population frequently mistrusted the state and the energy industry, and faith in the problem-solving strategies of experts and academics faded. Up until then, loyal state citizens had had experiences that had turned their trust into scepticism (Interview Szepan). In particular, the suspicion that state authorities would bend practice and law to favor the interests of nuclear energy advocates also supported doubts against the state within non-critical circles. They saw a

connection between the extension of atomic energy and democratic deficits and argued that the atomic lobby lacked transparency as well as honesty. Opponents perceived the relationship between the atomic industry and the population as one of traitors and victims. This mistrust in the truthfulness of state and the nuclear industry justified militant actions for some activists. Additionally, the police's brutal responses to militant acts and the obvious intention of some politicians to criminalize dissidents only increased skepticism and suspicion of authorities in politics and the economy in Germany. (Schüring 2015, 89 et seq.; Tompkins, *Grassroots* 2016, 117; Mende 2011, 330 et seq.).

Second, a different understanding of civil disobedience, as can be found in the US, is also emphasized. The historian Michael Hughes argues that non-violent protest in America has two origins that were missing in Germany and might have resulted in a greater openness to violent actions. According to Hughes, these influences stemmed from the American author and philosopher Henry David Thoreau's argument for disobedience to an unjust state, as well as from the Christian roots of the US American Civil Rights movement (Hughes 2014, 236–253). Violence as a means of political dispute could be found especially in leftist political activists, such as in communist cadres as well as the Sponti scene (Mende 2011, 333 et seq.). Third, resistance against nuclear power plants also expressed a critique of large-scale technology. In the opinion of many citizens, the costs of the facilities far exceeded the benefits, which indicated an estrangement from rationalist faith in progress (Engels 2006, 348).

On a global scale, different environmental, peace, disarmament, and anti-uranium movements inspired each other worldwide. This was possible through a significant transfer of ideas conveyed through activists, politicians, experts, social organizations, and the media, which functioned as transmitting agents for relevant information, ideas, and values. Transfer of ideas did not necessarily result in cooperation between ecological groups on a broader scale. There were a number of reasons why social movements did not always find it easy to cooperate. For one thing, there may have been too many social movements to be united under a single cause, sometimes even in one nation state. Moreover, despite common ideologies and views, each movement had a different focus, and the lack of a common "language" hampered this coalition building further. Another reason is that it was difficult to maintain international contacts and to

travel, both of which were vital to transnational collaboration. Travel distances and costs generally prohibited many activists from international involvement and transnational cooperation, at least until the last quarter of the twentieth century. Finally, the internal structure, different strategies and choreographies, cooperative culture, and diverse social milieus of the environmental action groups could sometimes lead to misunderstandings and be an obstacle to coalition building between groups and movements. Cooperation worked slightly differently at nuclear sites that were close to borders, because some of the "obstacles" described above only applied to a minor extent. Where nuclear sites were close to two or sometimes three different countries, people of diverse nationalities usually had similar interests. Furthermore, since the travel distances were rather minimal, it was easier to join and support local protests. This was the case in protests against nuclear plants in Wyhl and Cattenom (interview Avena) where French and German activists worked together, or in Kalkar, as the common protest of Dutch and German activists shows (Kirchhof and McConville 2015, 332–333; Tompkins, *Grassroots* 2016, 131 et seq.).

While activists learned from each other how to organize protests more effectively, government officials and police chiefs too learned from confrontations, as the Wyhl case shows. Since the interactions between activists and the police became increasingly violent, the latter developed special strategies to protect reactor sites and hinder activists from lasting occupation (Milder 2014, 197).

1.3. Presentation of main actors

Government, as the main funder of research and development, has been a strong proponent of nuclear power until recently, specifically through various ministries such as the Federal Ministry of Nuclear Affairs, which was founded in 1955, or the Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety, which was founded in 1986 under the name Federal Ministry for the Environment, Nature Conservation, and Reactor Safety. Bodies like the Reactor Safety Commission, which was set up by order of the Ministry of Nuclear Affairs in 1958, also had a strong interest in the sector. Responsibility for licensing the construction and operation of all nuclear facilities is shared between the German federal government and the federal states, which confers something close to a power of veto to both.

Science has been another driving force of the nuclear sector. The physicist Werner Heisenberg, Nobel laureate and science advisor to Chancellor Konrad Adenauer, opted for an early and strong engagement in atomic research to pave the way for industrial activities and international collaboration (Carson 2010; Carson 2002). Allied restrictions in applied nuclear research and technology were only lifted in 1955 when West Germany received sovereignty, but in the early 1950s a number of both large-scale nuclear research centers and university-based research reactors had already been founded, including big science establishments in Karlsruhe, Jülich, Geesthacht, and Munich (Rusinek 1996; Oetzel 1996; Interview Popp 2016). When the foundational mission of these centers came to an end in the 1970s, they diversified into many other fields of both basic and applied science, including renewable energies. But up until today, the centers have kept a foot in the nuclear realm and continue to conduct research and training, particularly in nuclear safety.

Private companies have been vital in the construction of German reactors. In the foundational period of the 1950s, however, the energy industry was hesitant to engage in the nuclear sector and it needed the state to set the scene (Radkau 1983). Once established, the nuclear industry became the core proponent of nuclear energy and continuously attempted to enlarge nuclear markets both domestically and abroad. The engineering company Siemens and its subsidiary company Kraftwerk Union (KWU) had a monopoly position in developing nuclear power plants for Germany for decades, until after the Fukushima nuclear disaster in September 2011 when Siemens withdrew from the nuclear industry. At the same time, it concluded its cooperation with the global leader AREVA—a French multinational group specializing in nuclear power and renewable energy, whose German branch is in Erlangen (Interview Schuch and Meyer zu Schwabedissen). This leaves four remaining nuclear energy companies: E.ON Kernkraft GmbH (the biggest German energy company), Vattenfall Europe Nuclear Energy GmbH (the Swedish company opposed the phasing out in Germany, which gave it a bad image), RWE Power AG (critical of nuclear power in the 1950s for cost reasons and pleaded for renewable energy), and EnBW Energie Baden-Württemberg (the third-biggest energy company, which suffered heavy financial losses after the phase out because of strong investments in nuclear power). The state subsidized or gave indirect financial benefits for the construction and operation of nuclear plants (at the expense of taxpayers). Thus, some critics point out that the costs for nuclear energy had

been held low artificially with the help of subsidies worth billions (AtomkraftwerkePlag—Atomlobby Konzerne and Atomlobby Subventionen).

Professional associations including the German Atomic Forum (founded 1959) and the Nuclear Society (founded 1969) often have strong formal and informal links to each other. For example, the former is a member of the latter organization and supports it financially. Moreover, there are links to politics, e.g. well-known institutions funded by the federal government, such as the Deutsche Bahn AG, the Helmholtz Center Munich and Berlin, and the Max Planck Institute of Plasma Physics, to name a few, are members of the German Atomic Forum and the Nuclear Society, among others, and support them through membership fees. Further associations are: Bürger für Technik (BfT), Energie-Fakten.de, Europäisches Institut für Klima und Energie (EIKE), Informationskreis KernEnergie (IK), Initiative Neue Soziale Marktwirtschaft (INSM), Internationale Länderkommission Kerntechnik (ILK), Nuklearia e.V., Reaktor-Sicherheitskommission (RSK), Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI), TÜV SÜD, Wirtschaftsverband Kernbrennstoff-Kreislauf und Kerntechnik (WKK), and Women in Nuclear (WiN) (Government's reply to minor interpellation 2014).

Trade Unions supported the use of nuclear energy for decades. When the "green" nuclear opponent Frank Bsirske became head of the trade union Ver.di (Vereinte Dienstleistungsgewerkschaft) in 2008, the new service union took a critical stance on this technology. At around that time, the trade union IG Metall (union for heavy industry, engineering, and electronics) started to cooperate with the anti-nuclear movement as well because they saw a future for jobs in the field of renewable energies. After the nuclear disaster in Fukushima in 2011, the trade union head of industry for coal mining, chemical industry, and energy demanded sufficient alternative energies, but no longer questioned the phasing out of nuclear energy (von Appen 2011, 36; AtomkraftwerkePlag—Gewerkschaften und Atomkraft).

Society: in the 1970s, German society became increasingly skeptical of nuclear power. The controversy was carried out at all societal levels and integrated intermediary social groups but also experts that founded alternative ecological research institutes; like the Freiburg Öko-Institut (Institute for Applied Ecology). It was founded in 1977 and is one of the most important institutes in its field in Germany. Protests against nuclear sites took direct democratic measures, engaged

in transnational cooperation, and resorted to extreme violence at times. Opposition to the construction of a power plant at the Badensian village of Wyhl was carried out by local inhabitants, especially wine farmers, but transnationally supported. For the first time, actions became especially violent with protests against the light-water reactor in Brokdorf, which caused "civil-war-like confrontations between police forces and opponents of the project" (Glaser 2012, 12; Kirchhof 2013, 2015; Kirchhof and Meyer 2014; Mende 2011; Milder 2014; Tompkins, *Better* 2016). The movement finally culminated in a new party, the GREENS, which was founded in 1980.

2. Showcase

Wunderland Kalkar

The Kalkar project started as an international collaboration in 1972 when the Belgian-German-Dutch Fast Breeder Nuclear Reactor Ltd. was founded in Essen. The company instructed the Siemens subsidiary Interatom to carry out the construction of a fast breeder sodium cooled nuclear reactor (SNR-300) in Kalkar and the foundation stone laying ceremony took place in 1973. The site was supposed to comprise a total area of 17,000 square meters with an output of 300 megawatts. The motivation to build the reactor was the limited uranium reserves in the Federal Republic of Germany. Advocates of atomic energy hoped that by building the breeder, minerals could be utilized efficiently and Germany could cease to be dependent on energy imports in order to generate electricity in the foreseeable future. The Rhenish-Westphalian Power Plant (RWE, which in 2000 merged with Vereinigte Elektrizitätswerke Westfalen, or VEW) originally chose the North Rhine-Westphalian village of Weisweiler as site for the fast breeder. But it seemed too risky to build a reactor in the broader Aachen city region because of its density of population. The idea was given up and the sparsely populated area around Kalkar was chosen instead (Marth 1992, 43). Soon criticism arose about the building of the fast breeder, based on doubts about the safety of nuclear energy, and in 1974 around a thousand people, predominantly from the Netherlands, took to the streets. A mass rally three years later was attended by 40,000 people (some authors speak of 50,000 [Tompkins, Grassroot(s) 2016, 129] or even 60,000 people, [Mende 2011, 332]) from France, the Netherlands and West Berlin. The police presence is regarded as the biggest in the history of the Federal Republic of Germany. The police were extremely violent and many demonstrators felt they were treated like terrorists. The writer, feminist, and co-founder of the German Green Party, Jutta Ditfurth, remembers how activists on their way to Kalkar were stopped by the police so that many could not reach their destination:

“A commuter train from Duisburg to Kleve was stopped in open country by Federal Border Guard helicopters. Federal border guards and police officers with truncheons, gas masks, tear gas canisters, and submachine guns surrounded the train and harassed the passengers. … They stopped our buses and closed motorways across the whole state. In their large Federal

Border Guard helicopters, they flew low over demonstrators, landed, beat them up, and flew off" (Mende 2011, 337).

According to the former Foreign Minister and co-founder of the Green Party Joschka Fischer, the events at Malville and Kalkar signaled the end of this form of extraparliamentary mass resistance against the construction of nuclear power plants. (Mende 2011, 337).

Another example further demonstrates that the government's treatment of members of the anti-nuclear-movement, or even of people who were only suspected to be opponents of nuclear power, was reminiscent of defense against terrorists. The German engineer Klaus Traube was managing director of Interatom, which had built the nuclear power plant SNR-300 in Kalkar. Originally a proponent of nuclear power, Traube reconsidered his views in the early 1970s after having read the Club of Rome's *The Limits to Growth*. When the German secret service suspected (falsely) that he had passed on secret information to the Red Army Faction (RAF), they illegally wiretapped Traube's apartment and he lost his job because the Federal Intelligence Service (Bundesnachrichtendienst or BND), one of the three German secret services, informed his employer about the issue. The illegal operation was uncovered in 1977, Traube was cleared of all charges, and the government was plunged into a crisis, as a result of which the then federal Minister of the Interior, Werner Maihofer, was dismissed (Mrusek 2011).

The anti-nuclear movement's opposition rose even more in the coming years, especially with the impact of the accident at the Three Mile Island nuclear power plant in the USA in 1979. Two court proceedings were launched against Kalkar, the second of which was the biggest in the history of the Federal Republic of Germany. Engineers that were involved in the process calculated that statistically every five years a "GAU" (a German acronym for worst-case scenario) would be a possibility at Kalkar (Kalter Kaffee 1984, 78, and interview with Szepan 2016). Moreover, experts expressed concerns about the coolant and the control process that was considered to be too difficult. On the one hand a Bethe-Tait accident (Bethe 1956) could not be ruled out; on the other hand liquid sodium was used for cooling, which was chemically especially aggressive. In contrast to the low-enriched uranium of conventional reactors, it was possible to also produce atomic bombs with the uranium that was used in the breeder, as Jo Leinen – leading figure of the anti-nuclear movement, later Environment Minister of Saarland –

pointed out. Because the technology would have to be exported to be profitable, countries which had not had atomic bombs before would now get the chance to gain access to them (Bretschneider 2011). Since the opponents of the construction lodged a constitutional complaint before the Constitutional Court, the German parliament's commission of inquiry ordered that construction be interrupted for four years in light of the safety concerns. Because of the difficulties involved in construction, the costs of the project also rose. From the initially planned 500 million marks (ca. 900 million euros), the price rose to 1.7 billion marks. In the end the whole project cost seven billion marks, which was 14 times higher than the original price (Meyer-Larsen 1981). When the North Rhine-Westphalian social-democratic/liberal coalition endorsed the anti-nuclear course, the Minister of Economic Affairs, Horst Ludwig Riemer (FDP), blocked the partial construction licenses, which caused a crisis.

The construction of SNR-300 was finally completed in 1985 and the reactor was put into partial operation: the sodium coolant was running through the coolant loop and the reactor was ready to receive nuclear materials. The operational costs totaled 105 million marks (today 93 million euros) annually. Against the wishes of the federal government and the Christian-democratic/liberal coalition, the state of North Rhine-Westphalia (which was the authority in issues concerning nuclear power) rejected the authorization to begin operations at the plant. The Minister of Social Affairs and Labour of North-Rhine-Westphalia, Friedhelm Farthmann (Social Democratic Party), who was responsible for the planning permission, argued that commissioning the plant was irresponsible because the risks were ultimately not calculable. According to the atomic law the federal government was able to enforce the authorization but did not want to carry the responsibility for the controversial SNR project alone. One reason for this decision was the disaster in Chernobyl that had happened in April 1986 and caused the atmosphere in West Germany to become increasingly critical of nuclear energy (Interview Avena 2016). No politician wanted to make unpopular decisions and risk negative results in the upcoming elections for the German parliament in 1987. Instead, the German government decided not to take SNR-300 into operation at that time. In the coming years, the applications underwent time-consuming examinations. According to SNR advocates the whole process was delayed so long that the closing down of the reactor was unavoidable. Moreover, since energy consumption had risen slower than expected, electricity suppliers were no longer interested in

the commissioning of the reactor. The termination of the project was announced by the then German federal Minister of Education and Research, Heinz Riesenhuber, on 21 March 1991. The reasons for this decision were a) the certain radioactive contamination of system parts when commissioning the reactor which b) would cause high costs and preclude further use of the complex buildings. The mega project, thus, had developed into a huge investment failure.

Successively the new and never used equipment and machines were sold because demolishing the whole complex would have cost another 75 million euros and was economically not possible. The owner of the reactor core was the RWE Power AG, but the company had no license for fuel which was enriched with plutonium. Therefore the plutonium was integrated into so-called MOX fuel elements (MOX = mixed oxide fuel which is an alternative to the low-enriched uranium [LEU] fuel used in the light-water reactors) in La Hague's reprocessing plant and eventually used in traditional nuclear power plants. Moreover, 12 unused blanket fuel assemblies that contained depleted uranium were transferred to the United States. Here the mostly decommissioned nuclear production complex, Hanford Nuclear Reservation on the Columbia River, took the assemblies in.

The German government sold the complex for 2.5 million euros at a public auction in 1995 to the Dutch entrepreneur Hennie van der Most, who converted it into a leisure park. The price was rather low for an object that had cost multiple times that to build, but since the German government did not want to cover the cost of dismantling the nuclear facilities at Kalkar itself it agreed to the price. At first the amusement park was called Kernwasser Wunderland ("Corewater Wonderland"), but this name probably reminded guests too much of the project's original purpose, so it was renamed later as Wunderland Kalkar ("Kalkar Wonderland"). The space, originally intended to become one of Europe's landmark nuclear projects, is now open to the general public. Besides hotels to stay in overnight, and bars, pubs, and restaurants for culinary enjoyment, the "wonderland" offers a family amusement park with climbing walls, white-water rides, flying carousels, and merry-go-rounds offering fun and adventure for the whole family (Kohlrausch/Trischler 2014, 229 et seq. and Wunderland Kalkar Webpage).

3. Events

3.1. German Atomic Program—First Nuclear Research Center

Who was involved: Federal government in general and the Federal Ministries of Atomic Affairs and Economics in particular, state governments of Bavaria and Baden-Württemberg, communities of Garching, Munich, and Karlsruhe, German Research Foundation, technical universities of Munich and Karlsruhe, atomic physicists, and NATO.

When and where did it take place: In the years 1952 to 1957 in the states of Baden-Württemberg and Bavaria and in the communities of Garching, Munich, and Karlsruhe.

What type of process was it—changes over time: Formation of nuclear research infrastructure and science policy process. When the Allied restrictions on nuclear science and technology seemed to come to an end in 1952, the German Research Foundation established a committee on atomic physics headed by the renowned physicist Werner Heisenberg. As early as November 1952, the commission demanded the establishment of a federally funded nuclear research center. Heisenberg, who worked in close collaboration with Chancellor Konrad Adenauer and became an informal advisor of the federal government, saw his hometown of Munich as the only possible location for the first German nuclear reactor station. He presented his ideas for a research reactor that would run on natural uranium, and thus not require US uranium enrichment facilities, to the federal Minister for the Economy, Ludwig Erhard. At the same time the state of Bavaria was improving its chances of being chosen as the reactor site by establishing the subject of nuclear physics at the Technical University of Munich. The driving force there was the physicist Heinz Maier-Leibnitz (Carson 2002, Carson 2010, Gleitsmann 1988, Eckert 1999, Trischler 2015). What followed was an intensely fought competition between the state governments of Bavaria and Baden-Württemberg with the cities of Karlsruhe and Munich with their respective technical universities as candidates for the siting of the federal reactor station. When the federal government finally decided on Karlsruhe, it took into consideration a veto by the NATO Supreme Allied Commander Europe, who favored a site more distant from the Iron Curtain than Munich.

While Munich ultimately lost out to Karlsruhe in the contest for the reactor, the Max Planck Society came up with a compensatory solution that enabled Heisenberg to save face by accepting the Bavarian offer to move the Max Planck Institute for Physics from Göttingen to Munich. In addition, Bavaria was compensated with a light-water reactor for research based in Munich (Forschungsreaktor München, or FRM), headed by Maier-Leibnitz and administered by the Technical University of Munich. It began operation in Garching, near Munich, in October 1957 as the first German nuclear reactor and was quickly followed by a rapidly expanding research infrastructure of reactor stations, including the big science centers at Karlsruhe, Jülich, Geesthacht, and Hamburg.

Evaluation of engagement events: The intervention of the NATO Supreme Allied Commander Europe in the siting conflict points to the interrelations of the civil and military dimensions of the nuclear sector. Although the scientific community tried hard to present nuclear science as a strictly civilian endeavor, not least to strip it of its historical origins in the so-called “Uranverein” (a project to develop nuclear weapons) under National Socialism, military rationales did play a substantial role in West Germany’s early nuclear history (Kelleher 1975, Cioc 1988, Küntzel 1992, Hanel 2015).

Relevant documents: articles in science and engineering journals, media reports in e.g., Süddeutsche Zeitung, Frankfurter Allgemeine Zeitung, Tageszeitung, Die Zeit, Der Spiegel, Federal Archives of Germany (German Atomic Program), State Archives of Bavaria and Baden-Württemberg, Archives of the Deutsches Museum (Papers of Heinz Maier-Leibnitz), Archives of the Max Planck Society and the Max Planck Institute for the History of Physics, State Archive Karlsruhe (GLAK), interview with the head of the Research Center Karlsruhe, Manfred Popp.

3.2. Civil Society Interaction—The Wyhl Example

Who was involved: Federal state government of Baden-Württemberg, Federal Ministry of the Interior, Kraftwerksunion (subsidiary of Siemens and AEG, a company that built nuclear power plants), planners, and activists.

When and where did it take place: In the years 1972 to 1977 and 1982 to 1987 in the state of Baden-Württemberg and in the community of Wyhl. Court cases took place in the cities of Fribourg and Mannheim.

What type of process was it—changes over time: Public participation and public communication. Before Wyhl was chosen to be the site for a nuclear power plant, politicians and planners considered the community of Breisach in the southwest of Germany as a possible site which – in the summer of 1972 – caused direct opposition because local farmers and wine growers expected negative environmental effects caused by emissions from the planned wet cooling towers. The federal state government did not want to risk the coming state elections and put the plans on ice. A year later it became publicly known that a new site in Wyhl had been found, which was only a few kilometers away from the original site and caused direct opposition again, this time well-organized. In 1973 and 1974 some 100,000 signatures and appeals against the construction of the nuclear power plant were submitted, including to the federal Minister of the Iinterior, who at that time was Werner Maihofer (FDP, liberals). This did not change the political decision at first and on 17 February 1975 the construction of the first reactor was started even though the final license for the building of the nuclear power plant had not yet been granted. This provoked opposition again, mostly from local people, many of them wine farmers, who spontaneously occupied the site and were supported in their resistance by activists from the nearby town of Fribourg. Crucial to this resistance was the successful fight against the erection of a lead chemical plant in Marckolsheim in neighboring French Alsace on the other side of the river Rhine. On 21 March 1975 the administrative court ruled that construction should be interrupted, which was overturned half a year later after an objection made by Minister-President of Baden-Württemberg, Hans Filbinger (CDU, conservatives). In autumn 1976 some 1,000 inhabitants demonstrated against Filbinger. Because the preparations for construction continued and site electricity connections were installed, the site in Wyhl was

occupied by protestors again. In March 1977 the administrative court withdrew the construction license for the plant. But two years later the administrative court of Baden-Württemberg opened up a second case. In 1982 the court of justice decided again that the construction of the nuclear power plant was legal and caused a rally of 30,000 opponents. Filbinger's successor as Minister-President of Baden-Württemberg, Lothar Späth (CDU, conservatives), declared that the construction of the nuclear power plant in Wyhl would not be necessary before 1993 and in 1987 he reconfirmed this decision, stating the plant would not be needed until the year 2000. The plant was never built and was turned into a nature reserve in the mid-1990s instead (Engels 2003).

Evaluation of engagement events: Wyhl has been interpreted by historians as a national site of memory deeply embedded in German culture (Rusinek 2003). The protest against the possible nuclear site in Wyhl was not the first protest against nuclear power in Germany, but the protest structures that were developed here are widely recognized to have served as an example for the West German environmental movement in later protests. Fribourg in Baden-Württemberg, the so-called "green" city, is a leader in environmental protection, renewable energy, and sustainability today. It produces less waste and consumes less water than comparable cities and is leading in solar energy research. The founding of certain related institutes was inspired by the environmental movement's protests; the Öko-Institut (Institute for Applied Ecology), founded in 1977 is one of the most important institutes in its field in Germany.

Relevant documents: newspaper articles, e.g., in Die Zeit (Kühnert 1977), reports by German non-governmental organizations, e.g., BUND (BUND 2014), film documentaries (Nabel 2013), Federal Archives in Koblenz, Archive for Social Movements Fribourg, protest flyers and calls to protest, squatting journal "Was wir wollen," archive of the Bundesverband Bürgerinitiativen Umweltschutz (federal association for citizen initiatives in environmental protection), Bonn.

3.3. Civil Society Interaction—The Wackersdorf Example

Who was involved: Bavarian State Ministry for Regional Development and Environmental Questions (StMLU), Deutsche Gesellschaft zur Wiederaufbereitung von Kernstoffen mbH" (DWK), cabinet, police, activists.

When and where did it take place: In the years 1980 to 1988 in Bavaria, especially the municipality of Wackersdorf in the district of Schwandorf.

What type of process was it—changes over time: Public participation and public communication. In 1980 the Bavarian State Ministry for Regional Development and Environmental Questions (StMLU) was authorized by the cabinet to find a site for a reprocessing plant (Wiederaufarbeitungsanlage, WAA). Two years later the Deutsche Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen mbH" (DWK) made an application to the StMLU for the granting of a nuclear licensing procedure for the construction and operation of a WAA in Wackersdorf. Even though other possible sites were debated, Wackersdorf was chosen because a “high potential of protest […] (was) not to be expected” (Schardinger 2012, 18). In 1985 the DWK finally decided on Wackersdorf as appropriate location for the construction site and announced the development plan. After the clearing of the woodland had started, a major demonstration with 30,000 people took place in Wackersdorf. Demonstrators occupied the building site, erected a hut village, and called it “Freies Wackerland” (free Wackerland) (Knoll 2006). Citizens’ initiatives, such as the Mothers Against Nuclear Power, raised objections to the reprocessing plant at a hearing in Neunburg. Here, they claimed for themselves and their families, especially their children, the fundamental right to life, health, physical integrity, and free development of their personality, which they did not see as being guaranteed if the reprocessing plant was built (Wurzbacher 1988, 1). The objections had to be handed in by a specific deadline to the approving authority, in that case the Bavarian Ministry of the Environment, which invited the people who protested to the hearing. The previous speaker before the women’s initiative at the hearing was Robert Jungk, author of the influential book *Der Atomstaat* (*The Nuclear State*). The audience the “Mothers” spoke to consisted of the approving authority, who were in favor of the reprocessing plant, representatives of the DWK, who had proposed the building of the reprocessing plant, and experts such as radiation biologists, who

were consulted by the approving authority to justify factually and technically the envisaged authorization. As Karin Wurzbacher, member of the Mothers Against Nuclear Power reports, the atmosphere in the hall was “in the beginning bored – now we patiently endure the “Mothers” and then we call it a day and [the men in the audience] showed a friendly face. In the end they were probably impressed. The representatives of the DWK showed no emotions whatsoever, they just reported their prepared answers” (Blomeyer and Wurzbacher 2016 and Wurzbacher 1988).

Up until the Chernobyl nuclear power plant catastrophe in April 1986 the Bavarian state government kept proclaiming publicly that hazards were not to be expected, either from the reprocessing plant or from any other nuclear power plant. The Chernobyl disaster – the so-called Super-GAU – then led to the peak of the violent disputes between police and anti-nuclear activists. West German police armed with stun grenades, rubber bullets, water cannons, CS gas, and CN gas were confronted by demonstrators armed with slingshots, crowbars, and Molotov cocktails at the site of the nuclear reprocessing plant in Wackersdorf (Germans 1986). Finally, the energy company VEBA changed its policies and was not interested in the reprocessing plant anymore. Additionally, the prominent advocate of the reprocessing plant, the Bavarian Minister-President Franz-Josef Strauss, had died, so the building plans were frozen in 1988.

Evaluation of engagement events: The plans for the plant were abandoned in 1988. It is still unclear whether protests, plant economics, or the death of Minister-President Franz-Josef Strauss, a strong proponent of the plant, in 1988 led to the decision (Isenson 2009).

Relevant documents: media reports in Süddeutsche Zeitung, Frankfurter Allgemeine Zeitung, Tageszeitung, Die Zeit, Der Spiegel, interview with the head of the energy company VEBA (Walraff 1989), film documentary about Wackersdorf (BUND 2015), printed papers of the Bavarian state parliament (Final report of the committee on Wackersdorf 1986), documents in the archive of the initiative Mothers against Nuclear Power, photographs of protests organized by the initiative by Cornelia Blomeyer, statements about and transcripts of appeals against Wackersdorf by Cornelia Blomeyer and Karin Wurzbacher, report by Thea Bauriedel about contemporary experiences in Wackersdorf, documents in the archive of the Deutschen Gesellschaft für die Wiederaufarbeitung von Kernbrennstoffen (DWK).

3.4. Civil Society Interaction—The Gorleben Example

Who was involved: Politicians, activists, German Society for the Construction and Management of Long-Term Waste Storage Units (DBE mbH), police, Federal Agency for State Protection and Counter Terrorism, Brennelementlager Gorleben GmbH (a subsidiary of the Society for Nuclear Services, GNS, which is owned by the energy companies E.ON, RWE, and Vattenfall Europe).

When and where did it take place: village of Gorleben in the district of Lüchow-Dannenberg (Lower Saxony). Controversies since 1977 up until recently, especially then when there are cask transports to the site in Gorleben.

What type of process was it - changes over time: Public participation and communication process. The only controversial nuclear project that still has relevance today in Germany is the repository site near the village of Gorleben (Lower Saxony, former West Germany). The decision for a storage site for nuclear waste came comparatively late. In the beginning the government did not see need for action to create a final repository because the quantity of waste was relatively small. For instance, high level waste did not exist because the reactor's fuel elements were brought back to the countries they came from. In cases where high-level waste was produced, the government planned to reduce the volume by reprocessing it and keep an open mind about further technological developments instead of deciding on certain methods just yet (Tiggemann 2010, 121 and Müller 1990, vol. 1, 525). Germany and other countries considered different ways of storing radioactive waste. Ideas that were considered and/or debated were storage in space, in ice caps on earth, or in the sea. All of these concepts were contested and the Federal Republic decided to concentrate on disposal onshore in salt deposits. Because of the existing salt domes in Lower Saxony, the government considered a site for storage in this state. To this end, in the years 1967–1978 it tested the former salt mine Asse II in the Asse mountains of Wolfenbüttel for research purposes as a deep geological repository for radioactive waste (Tiggemann 2010, 126 et seq.).

In the end the government decided in favor of storing nuclear waste at the Gorleben site, a decision that came about in 1977 under Chancellor Helmut Schmidt (SPD) and Prime Minister Ernst Albrecht (CDU, conservatives). At the site, there exists today:

1) a storage unit for radioactive waste which emits faint heat;

2) an interim storage unit for dry cask storage;

3) a conditioning plant (and a pilot plant in a salt dome).

1) The salt dome was intended to become a **long-term storage plant** for different kinds of radioactive waste and is run by the German Society for the Construction and Management of Long-Term Waste Storage Units (DBE mbH), but at present this use is still controversial and it has not yet been finally decided upon. It was the then Minister-President of Lower Saxony Ernst Albrecht (CDU) who decided on the site in Gorleben in 1977. Reasons for the choice were political and economic, especially the closeness to the East German border and the low population density in the area (Endlager Gorleben 2009). Soon public protest arose against the plans. In 1979 a convoy of 500 tractors went to Hanover, and on 31 March that year the biggest demonstration in the history of Lower Saxony took place with 100,000 people present. Afterwards, Minister-President Albrecht declared the plans as not feasible, which ended them (Jaschick 2010). In parallel, test drillings for the repository were carried out and were also accompanied by strong protests and a hut village was erected called “the micronation ‘Republik Freies Wendland’” (Free Republic of Wendland). The hut village was evacuated in the same year by police forces. Protests against the repository plans have continued ever since and have been carried out granted by action groups like Bürgerinitiative Umweltschutz Lüchow-Dannenberg (Citizens’ Initiative for Environmental Protection Lüchow-Dannenberg) or Bäuerliche Notgemeinschaft (Farmers’ Emergency Association).

2) The site for **an interim storage unit for dry cask storage** was built between 1981 and 1983 in the face of massive protests and collisions with police. Protesters suffered from fractured ribs, insured kidneys, fractured heads, and blinded eyes that were caused by water guns (Geisler 2010). Opponents of the transports were systematically spied on by police and the Federal Agency for State Protection and Counter Terrorism (Verfassungsschutz 2001). Because of

litigations and massive protests, the plant only started operating in 1995 with the first so-called Castor (**ca**sk for **stor**age and transport of radioactive material) transport. Two casks filled with spent fuel from various German reactor sites and high-level nuclear waste from reprocessing facilities in France where shipped to the interim storage facility in Gorleben. The second transport was shipped in 1996 with one cask from the reprocessing plant in La Hague and a third transport a year later, in 1997, included six casks. The fuel elements and vitrified waste block containers are in dry casks standing in a hall above ground and cooled by the surrounding air. They will stay in the casks for decades until they have cooled down from 400°C to 200°C and an appropriate repository has been found. Within these first three years the number of protesters increased from 4,000 to 10,000; police numbers increased to three times as much (from 7,600 to 30,000). As of 2011, 113 casks had been shipped to Gorleben. The Castor transports often become large events and receive remarkable national media coverage for several days in a row.

3) In Gorleben there is also a **"pilot conditioning plant"** where tests are made to condition the fuel elements in order to store them in a deep repository, and also to reload the containers for the vitrified waste blocks into containers suited to long-term storage. For technical reasons the dry cask storage containers are not suitable for long-term storage and cannot be placed in the salt dome.

Evaluation of engagement events: Like the anti-nuclear protests in the decades before, the clashes between opponents and police became extremely violent. The government's handling of it was perceived as inappropriate by the anti-nuclear movement and the broader public alike (Glaser 2012, 16, Narr 1997, Hintergrund 2010).

Relevant documents: Media articles e.g., Der Spiegel (Gorleben 1982), Gorleben archive (also accessible online, e.g., for Gorleben chronicle), online archive and active archive on documents for Bürgerinitiative Umweltschutz Lüchow-Dannenberg, archive of the Rechtshilfe Gorleben, Gartow, archive of the state parliament of Lower Saxony, Federal Archive in Koblenz, archive of the research mine Asse, Remlingen, Castor transport reports (Narr 1997).

3.5. Energy transition after Fukushima

Who was involved: Professional associations (e.g., the German Atomic Forum) and the Federal Government (Social Democratic Party and the Greens, later also the Christian Democratic Party), Germany's Ethics Commission on Safe Energy Supply, energy companies.

When and where did it take place: In the years 1998–2011 on the government level.

What type of process was it—changes over time: Communication process.

In the year 1998 the red-green coalition decided to phase out nuclear energy within 20 years (Munsberg 1998). In 2000 an agreement about the future operation of German nuclear power plants between the federal government and electricity supply companies was signed (Informationskreis Kernenergie 2015). After the tsunami and partial meltdown at Fukushima Daiichi in 2011, the topic received renewed societal attention. Chancellor Angela Merkel announced that all German power plants would be closed down by 2022 with eight of the seventeen operating German reactors being shut down immediately (Germany 2011). There have always been strong links between the government and professional associations based on collaboration that goes back decades. When the German government decided to phase out nuclear reactors, lobbyists such as the German Atomic Forum and the Nuclear Society tried to counteract the so-called Energiewende (energy transition). Since then, even the German Atomic Forum has made its peace with the goals of the German energy transition and has begun to focus its activities on keeping up engineering competence in dismantling nuclear reactors and radioactive waste storage (Interview Güldner). Energy companies like Areva changed their policy to focus on export and scientific research instead of processing fuel elements (Interview Schuch and Meyer zu Schwabedissen).

Evaluation of engagement events: The evaluations of the event vary in Germany and Europe. German society, politicians, and historians interpret the controversy over nuclear energy, including the phase-out, predominantly as a success story (Radkau 1987, Weitze and Trischler 2006) and regard the process as deeply democratic. In contrast, many other countries and academic colleagues are critical of the violence of the debates and protests (Hughes 2014) and consider the phase-out decision as "a misguided and potentially damaging interpretation of the

precautionary principle" (Moore 2012). This shows that nuclear energy and society's perception and interpretation of the developments vary considerably from country to country.

Relevant documents: Interviews with Matthias Schuch and Christian Meyer zu Schwabedissen from the German subsidiary of the French energy company Areva, and Ralf Güldner, president of the German Atomic Forum, documents from Federal archive, newspaper articles e.g., in Der Spiegel, TAZ, Die Zeit, Koblenz, agreement between the Federal Government of Germany and the energy supply companies, numerous media reports, archives of energy companies e.g., PreußenElektra, Hanover, archive of the Green Party, Berlin, Archive of Social Democracy (archive for documents on the SPD), Bonn, Archive for Christian-Democratic Policy (CDU), Sankt Augustin.

4. Facts & Figures

The purpose of this section is to give an overview of nuclear power in Germany. This section contains such data as the number of reactors, reactors' locations, technical and chronological details of reactors' construction, as well as statistics on electricity production, periodization, and social connections to nuclear construction. This data can be used as supportive material to the various sections of the country report and in order to understand the overall country's situation. Key dates and abbreviations used in this report are presented at the end of this report.

4.1. Data summary

- Germany shut down most of its reactors following the Fukushima accident in 2011.
- Previously, Germany had 17 operating reactors, which provided 25 percent of electricity in the country.
- Public opinion about nuclear power in Germany is negative.

4.2. Key dates and abbreviations

Key dates:

1955	After the Federal Republic of Germany gets its sovereignty, Chancellor Konrad Adenauer and the Federal Government establish Federal Ministry for Atomic Issues (16 October 1955), and Franz-Josef Strauss becomes minister for atomic affairs.
1956	Nuclear research centers in Berlin, Hamburg, Geesthacht, Jülich, and Karlsruhe.
1957	Establishment of the European Atomic Energy Community (EURATOM) in March and founding of the International Atomic Energy Agency at the end of July.
1957	The first nuclear reactor in Germany, called "nuclear egg," starts operations at the end of October. It is a research reactor at the Technical University of Munich.
1958	Establishment of the Reactor Safety Commission (Reaktor-Sicherheitskommission—RSK).
1959	Establishment of the German Atomic Forum (Deutsches Atomforum)—a platform to connect business, science, and industry for promotion of peaceful nuclear energy.
1959	The Atomic Energy Act is announced in Germany, which makes construction and operations of NPP legal.
1960	FBR project in Karlsruhe.
1960	The Atomic Energy Act comes into force in January and the first Radiation Protection Ordinance comes into force in September.
1961	In March, the Karlsruhe Nuclear Research Center puts FR-2 into operation, a heavy-water reactor and the first German-built reactor.

1961	First time electricity from a nuclear reactor is generated for the national grid by Kahl research NPP (VAK).
1967	Experimental nuclear waste storage in the Asse salt mine.
1969	Establishment of the German Nuclear Society (Kerntechnische Gesellschaft).
1974	Construction of first 1,200 MWe reactor in the world begins in Germany at Biblis NPP.
1976	Anti-nuclear demonstrations in Brokdorf.
1977	The first German-made FBR reactor is put into operation at the Karlsruhe Nuclear Research Center.
1977	Anti-nuclear demonstrations in Kalkar.
1981	Mass anti-nuclear demonstration in Brokdorf becomes violent.
1982	Beginning of foundation construction for Germany's first large uranium enrichment plant, in Gronau.
1986	Massive anti-nuclear demonstration against the construction of the Wackersdorf reprocessing plant in response to the Chernobyl disaster.
1986	Founding of the Federal Ministry for the Environment, Nature Conservation, and Reactor Safety (BMU).
1986	Decision to phase out nuclear energy in Germany within 10 years at the SPD party conference.
1986	The Brokdorf NPP is put into operation.
1990	German reunification and shutdown of nuclear power reactors in East Germany.
1998	Federal elections and formation of the coalition government, which decides to phase out nuclear energy as a future policy.
2009	New government cancels the phasing out of nuclear energy.
2010	The coalition government decides to give life extensions to NPPs.
2011	After the Fukushima disaster, parliament decides to speed up phasing out of nuclear power. Phase-out policy is reintroduced in Germany and eight reactors are shut down immediately after Fukushima.

Abbreviations:

AEG	Allgemeine Elektricitätsgesellschaft
ANP	Advanced Nuclear Power
BBR	Joint venture of Brown, Boveri & Cie. (UK) and Babcock & Wilcox (USA), now ABB
BBC	Brown Boveri
BBK	BrownBoverie-Krupp Reaktorbau
BNFL	British Nuclear Fuels Limited; renamed Westinghouse
BWR	Boiling Water Reactor (SWR 1000)
EPR	European Pressurized Water Reactor
EVU	Energieversorgungsunternehmen (energy supply enterprise)
ERAM	Endlager für radioaktive Abfälle (nuclear waste repository)
EURATOM	Europäische Atombehörde (nuclear agency)
FBR	Fast Breeder Reactor
GE/AEG	General Electric/ Allgemeine Electricitäts-Gesellschaft
HRB	Hochtemperatur Reaktorbau GmbH
IAEA	International Atomic Energy Agency
KWU	Kraftwerk Union
MWe	MegaWatt electrical
NPP	Nuclear Power Plant
OECD/NEA	Organization for Economic Cooperation and Development/Nuclear Energy Agency
PWK	Projektgesellschaft Wiederaufarbeitung von Kernbrennstoffen mbH (Society for reprocessing of nuclear fuel)
PWR	Pressurized Water Reactor
RSK	Reaktor-Sicherheitskommission (Reactor Security Commission)
SNR	Schneller Natriumgekühlter Reaktor
SWR	Siedewasserreaktor (boiling water reactor)
THTR	Thorium-Hochtemperaturreaktor (Thorium High-Temperature Reactor)
VAK	Versuchsatomkraftwerk (experimental atomic power plant)
WAK	Wiederaufarbeitungsanlage (Reprocessing plant)

4.3. Map of nuclear power plants

Figure 1 represents a map of nuclear power sites in Germany.

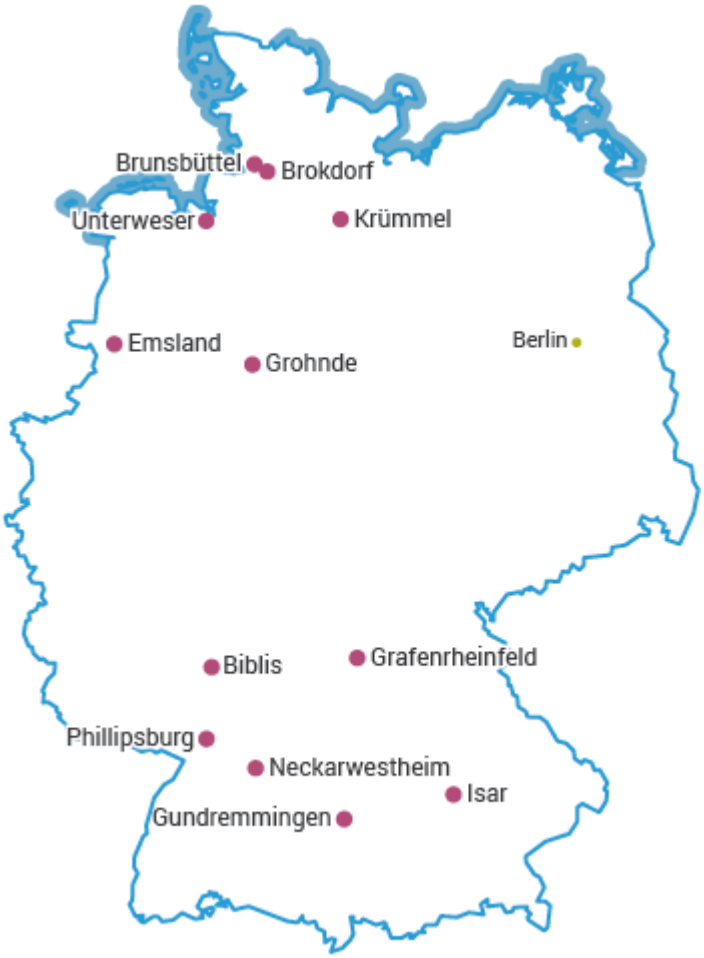

Figure 1: Nuclear power plants in Germany. Source: WNA 2016.

Currently, there are no operating power plants in East Germany because of the type of reactors built in the German Democratic Republic.

4.4. List of reactors and technical and chronological details

The tables below show the list of reactors, suppliers, operators, and dates.

Table 1: Operational commercial nuclear power reactors. Sources: IAEA 2016, WNA 2016.

No.	Name	Operator	Type	MWe net	Construction date	Grid power	Planned shutdown 2001	Agreed shutdown 2010	March 2011 shutdown & May 2011 closure plan
1	**Biblis A**	RWE	PWR	1167	1970	1975	2008	2016	shutdown
2	**Biblis B**	RWE	PWR	1240	1972	1977	2011	2018	shutdown
3	**Brokdorf**	E.ON	PWR	1370	1976	1986	2019	2033	2021
4	**Brunsbüttel**	Vattenfall	BWR	771	1970	1977	2009	2018	shutdown
5	**Emsland**	RWE	PWR	1329	1982	1988	2021	2035	2022
6	**Grafenrheinfeld**	E.ON	PWR	1275	1975	1982	2014	2028	shutdown June 2015
7	**Grohnde**	E.ON	PWR	1360	1976	1985	2017	2031	2021
8	**Gundremmingen B**	RWE	BWR	1284	1976	1984	2016	2030	end 2017
9	**Gundremmingen C**	RWE	BWR	1288	1976	1985	2016	2030	2021
10	**Isar-1**	E.ON	BWR	878	1972	1979	2011	2019	shutdown
11	**Isar-2**	E.ON	PWR	1400	1982	1988	2020	2034	2022
12	**Krümmel**	Vattenfall	BWR	1260	1974	1984	2016	2030	shutdown
13	**Neckarwestheim-1**	EnBW	PWR	785	1972	1976	2009	2017	shutdown
14	**Neckarwestheim-2**	EnBW	PWR	1305	1982	1989	2022	2036	2022
15	**Philippsburg-1**	EnBW	BWR	890	1970	1980	2012	2026	shutdown
16	**Philippsburg-2**	EnBW	PWR	1392	1977	1985	2018	2032	2019
17	**Unterweser**	E.ON	PWR	1345	1972	1979	2012	2020	shutdown

Before the Fukushima disaster, Germany planned to shut down its reactors as they reach over 30 years of operation. In 2010, the shutdown timetable was agreed upon as presented in Table

1. However, after Fukushima, eight reactors were shut down immediately and the scheduled shutdown time for other reactors was significantly reduced.

Table 2: Reactors in Germany shut down before Fukushima. Sources: IAEA 2016, WNA 2016.

No	Name	Operator	Type	MWe net	Construction date	Grid power	Shutdown	Status
1	**AVR Jülich**	AVR	HTGR	13	1961	1967	1988	
2	**Greifswald-1**	EWN	VVER V-230	408	1970	1973	1990	dismantled
3	**Greifswald-2**	EWN	VVER V-230	408	1970	1974	1990	
4	**Greifswald-3**	EWN	VVER V-230	408	1972	1977	1990	
5	**Greifswald-4**	EWN	VVER V-230	408	1972	1979	1990	
6	**Greifswald-5**	EWN	VVER-V213	408	1977	1989	1989	dismantled
7	**Großwelzheim**	HDR	BWR	25	1965	1969	1971	dismantled
8	**Gundremmingen A**	KRB	BWR	237	1962	1966	1977	dismantled
9	**Kahl**		BWR	15	1958	1961	1985	site unrestric-ted
10	**Kalkar KNK-2**	KfK	FBR	17	1974	1978	1991	
11	**Karlsruhe MZFR**	KBG	PHWR	52	1961	1966	1984	
12	**Lingen**	RWE	BWR	183	1964	1968	1979	safestor
13	**Mülheim-Kärlich**	SCN	PWR	1219	1975	1986	1988	
14	**Niederaichbach**	KfK	HWGCR	100	1966	1973	1974	site unrestric-ted
15	**Obrigheim**	EnBW	PWR	340	1965	1968	2005	
16	**Rheinsberg**	EWN	VVER-V210	62	1960	1966	1990	dismantled
17	**Stade**	E.ON	PWR	640	1967	1972	2003	
18	**THTR**	HKG	HTGR	296	1971	1985	1988	safestor
19	**Würgassen**	PreußenElektra	BWR	640	1968	1971	1994	

4.5. Data on Electricity Production, Nuclear Development and Companies

Share of electricity in 2013: gas declined 21% from 2012, and coal share rose before declining in 2014.

In the first half of 2014: gas-fired input dropped a further 14% to 16.6 terawatt-hours/TWh, lignite provided 69.7 TWh, hard coal 51.9 TWh, nuclear 45.0 TWh, wind 26.7 TWh, solar 18.3 TWh, biomass 25.6 TWh, and hydro 10.5 TWh. Total for six months: 264.3 TWh, of which 16.1 TWh was exported.

Germany's electricity production in 2014 (preliminary International Energy Agency figures): 615 TWh gross. In 2014 coal provided 275 TWh (more than half being lignite), nuclear 97 TWh (16%), gas 61 TWh, biofuels and waste 57 TWh, wind 56 TWh, solar 35 TWh, and hydro 25 TWh.

Electricity exports: about 34 TWh, compared with 20 TWh in 2012.

Imports: gas, coal, and oil worldwide. Apart from lignite and renewables, Germany has only a few domestic resources. In 2011, Russia provided almost 40% of gas, followed by Norway, the Netherlands, and UK, while 14% was produced domestically.

Annual consumption: about 6400 kWh per capita. Gross consumption was 576 TWh in 2014.

Generating capacity in April 2014: 169.6 gigawatt electrical/GWe.

GWe comprising: 12.1 GWe nuclear, 5.6 GWe hydro, 33.7 GWe wind (0.6 offshore), 36.9 GWe solar, 28.2 GWe gas, 21.2 GWe lignite, 26.3 GWe hard coal, and 5.6 GWe biomass (Fraunhofer Institute). In the first half of 2014 wind and solar PV had capacity factors of 18% and 11% respectively, compared with 85% for nuclear.

Nuclear development:

Until 2010, the 17 nuclear units totalled 20,339 MWe. The last came into commercial operation in 1989. Six units were boiling water reactors (BWR) and eleven were pressurized water reactors (PWR). All were built by Siemens-KWU. A further PWR had not operated since 1988 because of a licensing dispute. This picture changed in 2011, with the operating fleet being reduced to nine reactors with 12,003 MWe capacity, and then to eight reactors with 10,728 MWe. In 2000, two of Germany's biggest utilities, VEBA and VIAG, formed E.ON, which owned or had a stake in 12 of the country's 19 nuclear reactors, which were operating then. From January 2016, E.ON spun off Uniper, which will take over E.ON's global energy trading and power generation in and outside of Europe. E.ON will continue operating and slowly close down its nuclear generating capacity in Germany.

Equities of utility companies operating in Germany:

E.ON has equity in the following nuclear plants (January 2016), which will be managed by its subsidiary PreußenElektra: Isar-1 100%, Unterweser 100%, Krümmel 50%, Brunsbüttel 33.3% (all shut down), Grafenrheinfeld 100%, Gundremmingen B and C 25%, Grohnde 83.3%, Brokdorf 80%, Isar-2 75%, Emsland 12.5%.

RWE has equity in the following nuclear plants: Gundremmingen 75%, Biblis 100%, Emsland 87.5%.

Vattenfall has equity in the following German nuclear plants: Brunsbüttel 66.7%, Krümmel 50%, Brokdorf 20%. It has written off SEK 10.2 billion (€1.2 billion) on Brunsbüttel and Krümmel. Also in Sweden: Ringhals 70%, Forsmark 66%.

EnBW has equity in the following nuclear plants: Neckarwestheim 100%, Philippsburg 100%.

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