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The Rise and Fall of Nuclear Energy Use in Germany: Processes, Explanations and the Role of Law

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Abstract

After the disaster of Fukushima in March 2011, some countries and especially Germany changed their energy policy dramatically in order to end the use of nuclear fission in energy production. This has stirred interest in many countries. In this article the developments in Germany are considered against the historical and legal background. First, the article traces the different phases in the use of nuclear energy. As a second step it tries to find an explanation for why the nuclear exit occurred. Thirdly, it analyses the role of regulatory and constitutional law in the introduction and phasing out of nuclear energy use. Finally, some general conclusions are drawn on the advantages and drawbacks of nuclear energy and on lessons to be learned for socio-legal theory.

Keywords: energy law; phasing out of nuclear energy; precaution; participation; right to risk prevention; regulatory expropriation

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1. Stages in the Use of Nuclear Energy

1.1 Erection and Consolidation

In the post-war period, a fundamental consensus in German society and between political parties emerged according to which nuclear power should be used peacefully to foster societal welfare.[1] This became, for instance, manifest in the preamble of the Godesberg Manifesto of the Social Democratic Party (SPD):

> This is the contradiction of our time: Man has unleashed the power of the atom and now fears the consequences of his own creation; . . . Yet this is also the hope of our time: Man can make his life easier in the atomic age, free himself from anxiety and distress and create prosperity for all if he uses his ever growing power over the forces of nature solely for peaceful ends; . . ..[2]

The legal basis for the erecting of nuclear power plants (NPPs) was established in 1959 with the Nuclear Energy Act.[3] On its basis 32 commercial reactors were built between 1962 and 1989 becoming operational at different times. The nuclear share of overall electricity production in Germany was 30.7% in 1999, the year with its highest share, and gradually decreased to 22.4% in 2010, the year before the accelerated exit began.[4]

Up until the 1980s, various governing coalitions were striving to establish a so-called 'full' nuclear fuel cycle,[5] which included, apart from conventional NPPs, the construction of facilities for the reprocessing of spent fuel and for the enrichment of uranium, the building of plutonium-run 'fast breeders' and the swift establishing of final repositories for high-, medium- and low-level radioactive waste.[6] A parliamentary committee of enquiry which was established in 1979 juxtaposed two main scenarios—'Nuclear energy I' without a full fuel cycle and 'Nuclear energy II' with a full fuel cycle—and successfully recommended to postpone a decision between these two options.[7] This effectively slowed down the speed with which the scenario 'Nuclear energy II' was

1 cf Joachim Radkau *Aufstieg und Krise der deutschen Atomwirtschaft 1945 – 1975: Verdrängte Alternativen in der Kerntechnik und der Ursprung der nuklearen Kontroverse* (Fischer 1983).

2 Rudolf Steinberg (ed), *Reform des Atomrechts* (Nomos 1994) 7. Author's translation.

3 Act on the Peaceful Utilization of Nuclear Energy and the Protection against its Hazards (Atomgesetz, AtG) of 23 December 1959, BGBl. I, 814.

4 AG Energiebilanzen eV, Tabelle zur Stromerzeugung nach Energieträgern 1990 – 2010, <http://www.ag-energiebilanzen.de/> accessed 31 October 2012.

5 Due to the necessity of repositories, this vocabulary of 'full cycle' is misleading.

6 Adolf Birkhofer, 'Der nukleare Brennstoffkreislauf – Eine Analyse der Situation in der Bundesrepublik Deutschland' in Martin Czakainski (ed), *Perspektiven der Kernenergie: Kernenergiepolitik in der Bundesrepublik Deutschland, den USA und Japan* (Ernst Knoth 1984) 132–52.

7 Deutscher Bundestag (ed), *Zukünftige Kernenergie-Politik: Kriterien – Möglichkeiten – Empfehlungen*, Part I (Bundeshaus 1980) 194 .

pursued. Ultimately, its two main components, the fast breeder and the facility for atomic reprocessing did not materialise due to public protest, economic considerations and a change in the political landscape.

Already at the beginning of the 1970s, citizens' groups had emerged that were fundamentally opposed to nuclear energy and the fast breeder technology in particular. They organised determined but largely peaceful demonstrations that fostered general public awareness, such as the nine months' occupation of the building site for the NPP Wyhl at the Upper Rhine in 1975[8] or the 1981 mass rally against the NPP Brokdorf at the Lower Elbe, which was attended by about 50,000 people.[9]

They also took legal action before administrative courts against many installations. As will be explained later three main objections were presented against NPPs in the respective licensing procedures and court proceedings: the risk of a large accident could not be ruled out sufficiently, the contamination of exhaust air and waste water from normal operations and minor accidents endangered human health, and the safe disposal of nuclear waste was not ensured. In most cases, the actions brought were dismissed. Judgments of inferior courts were sometimes rather critical about NPPs, but if they quashed a licence, they were normally corrected by higher courts.[10] In very few cases the litigation led to an effective invalidation of authorisations. For instance, several authorisations for the NPP Mühlheim-Kärlich were invalidated for both procedural failure and disregard of risks of accidents from earthquakes.[11] However, even this success came out as a Pyrrhic victory. For, as the plant had meanwhile been built and put into operation the operator threatened to claim compensation from the *Land* (the federated state of the Federal Republic of Germany) for having rendered unlawful authorisations. The Land therefore struck a deal with the operator by which the latter renounced the filing of further applications for authorisations as well as the compensation claim in exchange for being allowed to transfer the amount of producible electricity to

8 Jens I. Engels, 'Geschichte und Heimat: Der Widerstand gegen das Kernkraftwerk Wyhl' in Kerstin Kretschmer (ed), *Wahrnehmung, Bewusstsein, Identifikation: Umweltprobleme und Umweltschutz als Triebfedern regionaler Entwicklung* (Technische Universität Bergakademie 2003) 103–30.

9 A minority tried to get past the site fence, whereupon the police used water cannons also against peaceful demonstrators. This was declared unlawful in a decision of the Federal Constitutional Court (Bundesverfassungsgericht—BVerfG), in which the fundamental significance of the freedom of assembly for democracy was emphasized. See BVerfG, Decision of 14 May 1985, 1 BvR 233, 341/81 (Brokdorf), BVerfGE 69, 315, 346.

10 The administrative court in Freiburg, for instance, found in a decision concerning the NPP Wyhl that the pressure vessel needed to be embedded in a concrete mantle for additional protection in case of a burst; however, this ruling was overruled both at the appeal and revision stages for exaggerating safety requirements, see BVerwG, Decision of 19 December 1985, 7 C 65.82 (NPP Wyhl II), BVerwGE 72, 300, 302.

11 BVerwG, Decision of 9 September 1988, 7 C 3.86 (Mülheim-Kärlich I), BVerwGE 80, 207, 216 f; BVerwG, Decision of 11 March 1993, 7 C 4.92 (NPP Mülheim-Kärlich II), BVerwGE 92, 185, 195.

production in its other NPPs.[12] Thus the closing down of the one NPP simply led to a life extension of other NPPs.

While the courts in general upheld authorisations, in some cases the policy change of a *Länder* government meant that an NPP that was already approved by the courts was ultimately not completed or not put into operation. For instance, the NPP Wyhl whose first authorisation[13] was upheld by the courts was not completed, since the *Land* government refused to grant further authorisations due to continuing public protest.[14] The fast breeder in Kalkar was built on authorisations that survived litigation but did not become operational, because the operation licence was refused by the *Land* government due to a political reorientation against the plutonium technology by the government of the Land Nordrhein-Westfalen.[15]

1.2 Vanishing Political Party Consensus

While the various governing coalitions of Christian, Free and Social Democrats maintained their support for nuclear energy until the end of the 1990s, a change in the political landscape during the 1980s paved the way for the 2002 political decision to exit nuclear power. In 1983 the party 'The Greens' entered the German *Bundestag*. The party had to a large part emerged out of the anti-nuclear movement and consequently supported a nuclear exit in the following years. In 1984, it introduced a 'Bill concerning the immediate decommissioning of all nuclear installations in the Federal Republic of Germany (*Atomsperrgesetz*)' into the *Bundestag*, which was however rejected by parliamentary majority.[16]

In the aftermath of the 1986 Chernobyl accident, the existing nuclear consensus of the big parties collapsed. The Social Democrats decided to end the use of nuclear energy at their 1987 party conference in Nuremberg. In December 1986 and February 1987, they introduced a 'Bill for the ending of the commercial use of nuclear energy and its safety-related treatment in the transition period (*Kernenergieabwicklungsgesetz*)' into the *Bundestag*, which was however rejected by the governing coalition of Christian and Free Democrats.[17]

In the following years, conflicts emerged between the Federal Environmental Minister of the governing coalition and those *Länder* governed by a majority

12 Herbert Posser, Malte Schmans and Christian Müller-Dehn *Atomgesetz: Kommentar zur Novelle 2002* (Heymanns Verlag 2003) s 7(1) a-d Nr 160.
13 On the practise of stepwise authorisations see s 3(1)(c).
14 Engels (n 8).
15 Willy Marth, *Der Schnelle Brüter SNR 300 im Auf und Ab seiner Geschichte* (Kernforschungszentrum Karlsruhe 1992), available at <http://bibliothek.fzk.de/zb/kfk-berichte/KFK4666.pdf, > accessed 29 November 2012.
16 BTDrs 10/1013 of 29 August 1984.
17 BTDrs 10/6700 and 11/13 of 9 February 1987.

of Social Democrats and partly the Greens. These states practiced what the opposing side called 'exit-oriented law enforcement', i.e. they asked in licensing procedures and supervisory measures for very comprehensive documentations, which delayed the approval of new licences and permits for alteration.[18] The Federal Minister then issued instructions to the renitent *Länder* ordering them to speed up procedures. Upon appeal the Federal Constitutional Court (BVerfG) held this practice compatible with the principles of federal division of competences.[19]

But even the ruling coalition of Christian and Free Democrats remained not untouched by the Chernobyl accident. They worked towards re-establishing a consensus with the Social Democrats by offering to remove certain privileges that characterized nuclear legislation in comparison to the more recent law concerning dangerous industrial installations.[20] However, as the Social Democrats and the Greens refused the offer, the resulting amendment to the AtG of 19 July 1994 brought about only minor changes.[21] Among other things, the safety level of new installations was elevated by requirements to armour them against plane crashes.[22]

1.3 Definitive Measures towards Nuclear Exit

In 1998, a governing coalition between the Social Democrats and the Greens emerged, which committed to the nuclear exit as 'comprehensive and irreversible' in its coalition agreement. After longwinded negotiations, the Federal Government concluded an agreement about the exit with the four largest German energy supply companies (ESCs), which operated the NPPs through subsidiaries.[23] The agreement was implemented by an amending law to the AtG of 25 July 2002.[24] It was established that no new plants for the production of energy would be authorised and that existing plants would only be allowed to produce individually allocated quantities of electricity. These quantities of electricity equalled about 32 years operating life for every plant. In order to give an incentive for the early shut down of older plants, a transfer of quantities from old to new plants was allowed.[25] Regarding nuclear waste disposal,

18 Horst Sendler, 'Anwendungsfeindliche Gesetzesanwendung – Ausstiegsorientierter Gesetzesvollzug' (1992), 45/2 DÖV 181ff.
19 BVerfG, Decision of 22 May 1990, 2 BvG 1/88, BVerfGE 81, 310, 331; see also BVerfG, Decision of 9 April 1991, 2 BvG 1/91 (Schacht Konrad), BVerfGE 84, 25, 31.
20 Federal Law on Protection against Immissions (Bundesimmissionsschutzgesetz—BImSchG). See the contributions in Steinberg (n 2) and further (n 82).
21 Act [. . .] on an Amendment of the Atomic Energy Act [. . .] (Gesetz [. . .] zur Änderung des Atomgesetzes [. . .], BGBl 1994, I S. 1618, Art 4.
22 S 7(2a) AtG in the version of 19 July 1994. See also n 60.
23 Posser and others (n 12) 285.
24 Law on the Structured Phasing Out of Nuclear Energy Use for Peaceful Purposes (Gesetz zur geordneten Beendigung der Kernenergienutzung zu friedlichen Zwecken), BGBl. 2002, I 1357.
25 S 7(1a-b) with Annex 3 AtG in the version of 22 April 2002 (n 24).

the possibility was introduced to store spent fuel in intermediate storage facilities on the site of NPPs.[26] Finally, it was foreseen to stop the delivery of spent fuel to French and British reprocessing plants by 2005.[27]

1.4 Exit from Exit

The exit strategy also remained in place during the period of the grand coalition between Christian and Social Democrats from 2005 to 2009. However, when in 2009 a new coalition between Christian and Free Democrats came to power they proclaimed to use nuclear energy as a 'bridge technology' in the transition to renewable energies.[28] Accordingly, the maximum lifetime of NPPs was planned to be extended while the prohibition of new installations should remain untouched.

Indeed, in September 2010, a new agreement between the Federal Government and the four major energy suppliers was concluded, which allocated additional producible quantities of electricity to the existing installations.[29] Under this agreement, NPPs built before 1980 would receive a production quota with which they could operate an average of eight years longer, while newer installations would be allocated additional production quota for further 14 years of operation. In exchange, the energy suppliers were required to pay a so-called fuel tax from which the transition to renewable energies should be funded. At the end of 2010, this concept of a lifespan extension in exchange for the generation of public revenue was made a law.[30]

1.5 Back to 2002 and Final Exit

When in March 2011 the reactors of Fukushima broke down, the debate about the use of nuclear energy in Germany reignited. The ruling coalition saw a new situation emerging. The Chancellor reasoned that if such big accidents could not be avoided in a technically advanced country like Japan, the use of nuclear power for generating electricity needed to be questioned fundamentally. In political fact a number of *Land* elections were imminent and the coalition parties feared drastic losses due to a majority of public opinion against nuclear energy. A few days after the Fukushima disaster the Federal Government determined a so-called nuclear moratorium allowing a three months period of special

26 S 6(4) AtG in the version of 22 April 2002 (n 24).
27 Posser and others (n 12) 289.
28 Koalitionsvertrag zwischen CDU, CSU und FDP vom 26. October 2009, 29 <www.cdu.de/doc/pdfc/091026-koalitionsvertrag-cducsu-fdp.pdf>accessed 30 October 2012.
29 Förderfondsvertrag Bund-EVU v. 6.9.2010, <http://www.scribd.com/doc/37160969/Vertrag-zwischen-Bundesregierung-und-EVUs-vom-06-09-2010> accessed 30 October 2012.
30 Eleventh Amendment of the Atomic Energy Act of 8 December 2010, BGBl. 2010 I 1814, Art 1; Nuclear Fuel Tax Act of 8 December 2010, BGBl, 2010 I 1804.

safety check of all NPPs. Out of the 17 authorised NPPs the seven oldest which were built before 1980 had to immediately stop operation for three months and one built in 1984, which due to safety problems was not operational in early 2011, had to remain inoperational also for three months.[31] Shortly afterwards, the 'Ethik-Kommission Sichere Energieversorgung' ('Ethical Commission concerned with reviewing "Safe Energy Supply"') of independent and highly respected experts was appointed to advise on a strategy for nuclear exit. Based on its suggestions,[32] a legislative package was enacted that amended the AtG and at the same time renewed or introduced different pieces of legislation concerning the energy industry.[33] Here, a grand deal became manifest in which exit from nuclear energy production was exchanged with the facilitation of the transition to renewable energies. It included that the additional production quota granted in the 2010 amendment were withdrawn. Furthermore, the inoperation of the seven plus one installations was turned from being temporary to final. However, the unused production quantities granted to those NPPs in the 2002 exit legislation could still be transferred to other NPPs.[34]

2. An Attempt to Explain the Nuclear Exit

The German policy towards the nuclear exit has depended on external and internal factors. It still awaits socio-political analysis so that the following remarks are more those of a long time participant observer.

Externally, the exit was only feasible if the EU and international law context allowed Germany to choose its own way. On the European level, the 1957 Treaty establishing the European Atomic Energy Community (EURATOM) entrusts the Community to promote research into, and the peaceful use of, nuclear energy, to establish safety standards and to ensure the supply with fissile materials. However, it does not commit the Member States to use nuclear energy nor does it authorise the Community legislator to prescribe the use of nuclear energy.[35] On the international level, the 1968 Nuclear

31 See the chronology of measures compiled by the competent ministry at <http://www.bmu.de/atomenergie_sicherheit/fukushima_folgemassnahmen/chronologie/doc/48447.php> accessed 30 October 2012.

32 Ethik-Kommission Sichere Energieversorgung *Deutschlands Energiewende – Ein Gemeinschaftswerk für die Zukunft* (Berlin 2011) <http://www.bundesregierung.de/Content/DE/_Anlagen/2011/07/2011-07-28-abschlussbericht-ethikkommission.pdf> accessed 30 October 2012.

33 Thirteenth Amendment of the Atomic Energy Act of 31 July 2011, BGBl. I 1704; see also the overview of the legislative package in Dieter Sellner, Frank Fellenberg, 'Atomausstieg und Energiewende 2011 – das Gesetzespaket im Überblick' (2011), 30/17 NVwZ 1025.

34 S 7(1b) AtG version of 31 July 2011 (n 33).

35 See Art 2, 30, 31 EURATOM Treaty and Dieter H Scheuing, in Walter Bayer and Peter M Huber (eds), *Rechtsfragen zum Atomausstieg* (Spitz 2000) 87. Germany can however not impose its own safety standards on NPPs situated in other MS as long as these meet the EURATOM standards, see ECJ C-115/08 *Land Oberösterreich v CEZ* [2009] ECR I–10265, paras 135,136.

Non-proliferation Treaty bans states that do not already own nuclear weapons to develop, acquire or possess them but leaves their right to use nuclear energy for peaceful purposes untouched.[36] This also includes the right to uranium enrichment and the reprocessing of nuclear fuel as long as it serves peaceful purposes. However, as a matter of course, it does not commit any state to use nuclear energy. Under EU and international law, Germany was therefore not hindered in ending the use of nuclear energy.

Internally, the new policy can be understood to have many causes. As a framework of analysis I suggest to point to the relative power of the major stakeholders. Such power is located on two levels: that of forming political opinion and that of providing economic services. Two major positions were at stake: on the one side, emerging 'from below', the critical public and its political representatives, and on the other, the energy industry and related policy-makers. They shall be described in turn.

2.1 The Critical Public

As mentioned before, already at the beginning of the 1970s citizens' action groups against nuclear energy were protesting against planned NPPs. Demonstrations were organised, media coverage was prepared, and counter-expertise was organised. Significant for the emergence of counter-expertise was that academics in sciences and law acquired NPP-critical knowledge, distributed it in the respective specialist literatures and introduced it into licensing and court procedures. The growing movement of citizens' action groups gave rise to associations and critical think tanks, such as the *Ökoinstitut* in Freiburg, which acquired and provided knowledge about risk assessment and influenced legal doctrine. Public opinion was also shaped by public hearings in licensing procedures under the AtG. These hearings were sites for in-depth debates about safety questions and were also often the stage for emotional confrontations, as critics frequently felt that the decision was already taken and that they did not have a fair chance of changing it. Of particular importance for the success of the citizens' action groups was the bridging between academics and the rural population. This link between left intellectuals and conservative farmers was politically effective, since it allowed the use of multiple political channels.[37]

As already pointed out, a political wing of the citizens' action groups emerged, which gradually became independent from the grassroots—the political party of the Greens. From their foundation onwards, the Greens pursued the course of an accelerated nuclear exit and succeeded for the first time in

36 Arts III and IV of the Treaty.

37 cf Radkau (n 1); Engels (n 8); Herbert Kitschelt, *Kernenergiepolitik. Arena eines gesellschaftlichen Konflikts* (Campus Verlag 1980).

2002 as coalition partners of the Social Democrats. In all stages, the Greens supported an early shut down of nuclear installations, but compromised on longer periods of the exit with the Social Democrats in 2002 and the Christian and Free Democrats in 2011. In conclusion, civil society gradually spawned critical views among expert networks and in public opinion at large which at later stages transformed into programmes and activities of political parties and governmental majorities.

2.2 Energy Industry

The energy industry, and in particular the big Four which owned NPPs, were of course the opponents of the critical public. The industry's power appeared on both the epistemological level of political opinion formation and the 'objective' level of economic importance. On the level of opinion formation the energy sector was able to incite favourable expert reports and legal opinions. In effect, this corresponded to the strategies of the critical public, but while the latter relied on bottom up public discourses the energy industry drew on its significant financial and organisational means.[38] Its major think tank of science and law became the *Gesellschaft für Reaktorsicherheit (GRS).* In addition, the association *Verein Deutsches Atomforum* was founded to organise publicity campaigns highlighting the alleged safety and climate friendliness of nuclear energy.[39] Still, more influential than the epistemological leverage was the 'objective' economic importance of the energy industry as a supplier of electricity and as a large investor. The political decision-makers could hardly have enacted the nuclear exit if its consequence was that the electricity supply were to become endangered, the climate protection targets missed, or the big ESCs were to go bankrupt.

Concerning power supply and climate policy the Ethik-Kommission took the view that the nuclear exit, if initiated as a 'great common effort' ('Gemeinschaftswerk'), was indeed manageable, with renewables successively replacing nuclear power, energy self-sufficiency remaining ensured, energy efficiency measures reducing power consumption, climate gas emissions remaining within targets in spite of continued but decreasing use of fossil fuels, and all measures being affordable.[40] Given the uncertainty in all such forecasts it was certainly a bold step of the Kommission to endorse an accelerated exit.

38 See, for instance, on personal affiliations of experts with the nuclear sector AG Atomindustrie, *Wer mit Wem in Atomstaat und Großindustrie* (Zweitausendeins 1987).

39 The then Federal Environment Minister Gabriel called it in a critical speech at the occasion of its 50th anniversary (1 July 2009) the 'propaganda headquarters of the nuclear industry', see report by the communal information portal ForumZ, available under <http://www.forumz.de/Default.asp?Menue=18&NewsPPV=5698> accessed 30 October 2012.

40 Ethik-Kommission (n 32) ch 5.

But this was facilitated by the political irritation caused by the Fukushima disaster and the ensuing change of minds of the political leaders.[41]

Regarding the economic situation of the big ESCs that operated NPPs, alternative business activities were to be found for them. The most obvious new opportunity was to invest in renewable energies. Since the beginning of the climate change debate the big firms had been aware of the need to turn to new energy sources. In order to facilitate this shift it became part of the exit deal that the energy industry would be supported by public financial and management assistance for infrastructure for the generation and transmission of energy.[42] Additionally, there have been financial subsidies of energy generation from renewable sources. ESCs have, like small producers, been able to take advantage of the fixed feed-in tariff[43] or to directly sell their electricity and receive a market premium complementing the market price up to the level of the feed-in tariff.[44] A new vision was imaginable of a national and European network of big centres generating renewable energy where it could be produced most efficiently: hydroelectric power stations in mountainous regions with a high degree of rain, wind farms at the coasts, large areas with solar panels in the sunny south, and bio-mass cultivation in farmland areas, all connected via transmission lines that flexibly transport power away from where there is too much and deliver it to where there is too little or where it can be stored.[45] It is furthermore significant that the major ESCs increasingly engaged

41 See above n 31. The expectations have meanwhile widely become true: The renewables have made good the majority of phased out nuclear power with efficiency measures filling the remaining loophole, see Stefan Lechtenböhmer, Sascha Samadi, 'Blown by the wind. Replacing nuclear power in German electricity generation' (2013) 25 Environmental Science and Policy 234. The import/export balance has remained positive: In 2011 56 TWh were exported and 50 TWh imported. See communication by Federal Ministry for the Economy, available at <http://www.bmwi.de/DE/Themen/Energie/stromversorgung,did=292510.html>, accessed 26 November 2012; The reduction targets for climate gas emissions were met, see *2011: Weniger Treibhausgase trotz weniger Atomenergie,* in: scinexx. Das Wissensmagazin, 26 November 2012 (<http://www.scinexx.de/wissen-aktuell-14662-2012-04-13.html> accessed 26 November 2012). It is true, however, that the increase in electricity prices will be much higher than originally expected: the charge reflecting the feed-in tariff for renewable electricity will lead to an increase of about 5.3 Ct per kWh of the basic price for a household of about 20 Ct. This is due to the expansion of electricity production from renewables. See Bundesministerium für Wirtschaft und Technologie, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, *Erster Monitoring-Bericht "Energie der Zukunft"* 2012, 39.

42 cf Netzausbaubeschleunigungsgesetz Übertragungsnetz of 28 July 2011, BGBl. I, 1690.

43 The feed-in tariff is paid by the operator of the grid. The latter can reclaim his costs from the transmission system operators, whose costs are levelled and financed jointly by the energy suppliers which finally pass on their costs to the end-consumers by way of a renewable energy charge.

44 Act on Renewable Energies (Erneuerbare Energien Gesetz) ss 33 a-i EEG. The ESCs can also sell renewable energy as green energy to customers who are willing to pay the higher cost price.

45 Bundesministerium für Wirtschaft und Technologie, Energiewende auf gutem Weg (BMWi) 2012; Commission, Energy 2020. A Strategy for Competitive, Sustainable and Secure Energy, COM (2010) 639 final.

in the development of a European network of installations and lines for renewable energy and also in large-scale projects, like DESERTEC, which aims at harvesting solar energy in North Africa and transporting it to Europe.[46] The political system could thus trust that the big ESCs would not economically collapse, because profitable and effective alternatives opened themselves up in exchange for the closing down of their NPPs.[47]

In conclusion, the political system could afford to follow the critical public opinion because power supply appeared to be secured without nuclear energy, and the big ESCs had a realistic opportunity of reorientation. It must be added, however, that the exit decision would hardly have been taken had the catastrophes of Chernobyl and Fukushima not occurred. They caused the crisis that tragically seems to be needed for any fundamental change of policies.

3. The Role of Law

As already indicated, the political struggle and economic conditions underlying the introduction and phasing out of nuclear energy were reflected in the emergence of a wealth of regulatory law. Underpinning these regulatory regimes were more fundamental issues of constitutional law. I will discuss the regulatory and constitutional levels in turn.

3.1 Regulatory Law

Throughout the past decades the interplay of legislators, regulators, courts and jurisprudence, incited by public debate and litigation, gave rise to a rather stringent law regulating nuclear energy use. It could be argued that a study of this legislation is irrelevant as most of it will soon become obsolete. However, the study can show that regulation, as sophisticated as it may be, can nevertheless be unable to control an ultra-hazardous technology like nuclear power and to persuade civil society to accept the technology. Alternatively, those countries which decide to maintain the nuclear path may learn from the achievements and drawbacks of the German example how to develop their own regulatory framework.

46 See Commission of the European Union, An Energy Policy for Europe, Communication of 10 January 2007, COM (2007) 1 final.

47 It should however be added that the fostering of the big ESCs will hamper the existing bottom up structure of producing and providing electricity in small installations and on a regional basis which could be combined with new technology of storage on the spot, a temporally better organised demand and a regional politics of energy efficiency and sufficiency. See Bernd Hirschl, *Kommunale Wertschöpfung durch Erneuerbare Energien (*Institut für ökologische Wirtschaftsforschung 2010).

3.1.1 Precaution

The use of nuclear energy has been a trigger for the establishment and shaping of the precautionary principle in this regulatory area as well as in general environmental law. German environmental law has its origin in police law. Police law empowers (and nowadays also obliges) authorities to prevent 'danger' (*Gefahr*) of damage to human health and other concerns, danger meaning a situation of sufficient knowledge prognosticating the high probability of significant damage.[48] The AtG of 1959 was the first law to make this standard more sensitive to situations of insufficient knowledge and low probability of damage by requiring that 'precaution against harm necessary according to the state of science and technology must be taken'.[49] This was a significant step reacting to the novelty and high damage potential of this technology. Case law interprets precaution to refer to a situation of 'risk' in which uncertainty exists or where the available knowledge suggests that because of its seriousness the likelihood of damage should be minimised.[50] The cited reference of Section 7(2) AtG to 'the state of science and technology' is interpreted to mean that not only the best available technology is to be utilised, but that if the state of science asks for more than is available the NPP must not be permitted.[51] Not only mainstream risk analysis but also dissenting opinions are to be taken into account.[52] With regard to the onus of proof, the operator carries the burden to provide the relevant information and thus be denied the right to operate if the information is found insufficient to fulfil the safety requirements.[53]

Precaution is however not endless. According to the BVerfG 'absolute safety' cannot be demanded, since this 'would mean to misjudge human cognitive capabilities and would furthermore ban every governmental authorisation of the use of technology.'[54] This means that there is a realm of 'residual risk' 'below' the area of precaution that must be accepted as 'socially adequate'. Its

48 BVerwG, Decision of 26 February 1974, I C 31.72 BVerwGE 45, 51 (57).

49 S 7(2) n 3 AtG.

50 In international and EU law, the precautionary principle applies only to situations of uncertainty. German law includes both uncertainty and low likelihoods of damage. See Michael Kloepfer, *Umweltrecht* (3rd edn, Beck Verlag 2004) S 4.

51 BVerfG, Decision of 8 August 1978, 1 BvL 8/77 (Kalkar), BVerfGE 49, 89 (136). This concept is stricter than the one that was later on introduced for dangerous installations in general. The latter requires that risk must be minimised according to using best available technology, thus not also according to what science may suggest in addition (s 5 (1) BImSchG).

52 BVerwGE 72, 300, 316 (NPP Wyhl II); BVerwG, Decision of 14 January 1998 (NPP Mülheim Kärlich III), BVerwGE 106, 115 (121).

53 BVerwGE 104, 36 (43) (NPP Obrigheim). For measures of installation monitoring, the authorities carry the burden of material proof (BVerwG, Decision of 22 January 1997 – 11 C 7.95 (NPP Obrigheim), BVerwGE 104, 36 (43f).

54 BVerfGE 49, 89 (143) (Kalkar).

boundary with precaution is outlined in the rather general formula of 'practical reason'.[55]

The general principle of precaution is the basis for more concrete sublegal ordinances (*Rechtsverordnungen*) and administrative guidelines (*Verwaltungsvorschriften*). In relation to radioactive emissions from an NPP during regular operations (*Normalbetrieb*) as well as in case of incidents (*Störfälle*) thresholds for the radioactive contamination of the affected population were established.[56] The control of incidents is to be reached by a complex bundle of safety measures organised on two levels: measures ensuring the avoidance of incidents (such as by quality assurance of technical components, best qualification of personnel, reactor scram in abnormal situations, etc) and measures ensuring the control of incidents should they unexpectedly occur (such as by residual heat removal after loss of coolant and by capture by the containment of radioactivity from a hypothetical core meltdown).[57] In this way, the most serious imaginable catastrophic accident—a core meltdown plus leak in the containment—was expected to be so unlikely that it could be regarded as negligible residual risk. The likelihood was to be calculated applying deterministic as well as probabilistic risk assessment methodology. In probabilistic terms it was commonly understood that this likelihood had to be (and was in fact) less than about one per million in a year of operation of a reactor.[58]

This concept was later on somewhat revised. After the Chernobyl accident it was accepted that the core meltdown and the failure of the containment was less unlikely than henceforth assumed. Therefore, as a 'mitigation measure', a controlled release of radioactivity was allowed to prevent the explosion of the containment.[59] After the events of '9/11' in 2001 more attention than before was given to the possibility of terrorist attacks on NPPs. The BVerwG ruled that they were not a residual risk but demanded precautionary measures.[60]

55 ibid. For a critique of the vagueness of this formula see Herbert Sommer, 'Praktische Vernunft beim kritischen Reaktor' (1981) 34/5 DÖV 654–660.

56 At the moment, this is concerning the regular operations 1 millisievert for the whole body dosage per year and person and in case of incidents 20 millisievert, see s 5 Strahlenschutzverordnung (StrlSchV). Other radiation sources in the vicinity of the installation were also to be included into the actual dose, see BVerwG, Decision of 22 December 1980, 7 C 84.78 (NPP Stade), BVerwGE 61, 256 (264).

57 Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), Sicherheitskriterien für Kernkraftwerke of 21 October 1977, 1977/202 BAnz 1977. English translation in Gesellschaft für Reaktorsicherheit (GRS) *Safety Codes and Guides. Translations* (GRS 1978). They were later on further differentiated, see the latest version in BMU, Sicherheitskriterien für Kernkraftwerke, Revision D, April 2009 <http://www.bmu.de/atomenergie.sicherheit/rechtsvorschriften.technische.regeln/sicherheitskriterien/doc/44296.php> accessed 31 October 2012.

58 Werner Rengeling, *Probabilistische Methoden bei der atomrechtlichen Schadensvorsorge* (Carl Heymanns Verlag 1986) 45–58; Gesellschaft für Reaktorsicherheit, Risikostudie Kernkraftwerke Phase B (Verlag TÜV Rheinland 1989), 772.

59 BMU (n 57) No 2.3 (4).

60 BVerwG, Decision of 10 April 2008, 7 C 39.07 (Zwischenlager NPP Brunsbüttel), BVerwGE 131, 129 (144–46).

3.1.2 Beyond safety

As shown above, one criticism of nuclear energy is that it is not needed because alternative energy sources, in particular renewables, are available. This argument has also been raised in court litigation. While at first sight the preconditions of an authorisation according to the AtG are exclusively concerned with the safety of the plant,[61] the wording of the relevant provision could be interpreted to provide the licensing authority with discretion to consider further aspects. According to constitutional law doctrine on the protection of basic rights, whether an administrative body may have discretion or not depends on whether the regulation is of a 'repressive' or 'preventative' nature. It is seen as repressive if the respective activity is generally dangerous and unwished for, and shall therefore only be permitted under exceptional circumstances as determined by administrative discretion. It is preventative if the activity is only suspected to be harmful and the operator can therefore be given a right to the activity provided he fulfils the legally determined preconditions.[62]

Considering that in the initial versions of the AtG one of the explicit objectives was to further the development of nuclear power, the BVerfG rejected the first option. It rather interpreted the regulation as preventative.[63] Nonetheless and in deviation from the established doctrine that understood such laws in binary terms as either repressive or preventative, it acknowledged that the authorities had discretion because of the uncertainty over nuclear safety and the potential risks of serious damage. Authorities were therefore allowed to apply criteria beyond mere safety concerns and consider, for instance, geographical conditions of the siting of NPPs.[64] However, the possibility to dispute energy demand for a new NPP and point to the availability of alternative energy sources was rejected.[65]

3.1.3 The stepwise licensing of installations

NPP are complex installations, which are usually constructed and made operational in steps. The AtG allows this by providing the possibility of partial authorisations such as for the location, the foundation, the building, the machinery and the operation of the NPP.[66] While this stepwise approach reflects how NPPs are built in fact, it does entail the risk that the project is never assessed as a whole. In addition, given the long time scale involved in the building of an NPP, the state of risk knowledge and available technology

61 S 7 AtG of 1959. In 2002 new NPPs were made unpermissible (n 24).
62 cf Kloepfer (n 50) s 5, paras 53–62.
63 BVerfGE 49, 89 (145–47) (Kalkar).
64 Hans Fischerhof, *Deutsches Atomgesetz und Strahlenschutzrecht. Kommentar* (2nd edn, Nomos Verlag 1978) s 7 n 17, 20, 24.
65 BVerwG, Decision of 9 July 1982, 7 C 54/97, DVBl. 1982, 960 (961).
66 S 7(4) AtG with s 8 BImSchG.

can change. These problems of time lapse have been solved by a rather sophisticated set of rules.

The remedy the legislator and the courts developed was to require that a so-called provisional positive safety assessment of the entire installation (*vorläufiges positives Gesamturteil*) must be made and successively be perfected, in parallel to the issuing of partial licences.[67] This *Gesamturteil* is regarded as an administrative act in itself that can be separately challenged by legal action.[68] A particular feature of it is that it can be (and has to be) changed, when new conditions emerge due to further detailed assessments or changes in the factual or legal situation.[69] However, if the construction of an installation was completed on the basis of a number of partial licences and new requirements emerge due to a new factual or legal situation the final licence for the operation of the plant cannot simply be denied, because the provisional *Gesamturteil* has now gradually coagulated into a final overall judgement.[70] Should the licensing authority nevertheless wish to refuse the operational licence it cannot simply do so but needs first to withdraw the relevant partial construction licences. This however entails the duty that the operator is financially compensated, unless according to the new facts or law the NPP appears to be a significant danger to human health or the environment.[71] In contrast to this, to the extent that in the often long period between the issuing of a licence and a subsequent court decision about its validity a new technological or scientific state of the art emerges, or a new (non-retrospective) legal situation arises, the court takes the situation at the time the licence was issued as a reference point.[72]

3.1.4 Supervisory orders, modification permits and new safety requirements

Once an NPP has been authorised it is subject to supervision by the authorities during its operations. In circumstances where the supervising authority establishes that an installation does not meet legal and licensing requirements, it can order that this state is remedied.[73] In the case of significant or repeated violation, it can also withdraw the licence and is even obliged to do so, if a significant danger exists and subsequent orders would not change the situation.[74] In such cases, compensation of the costs of remediation is not provided for.[75]

A further problem with the time lapse emerges, if the operator herself wishes to modify parts of the installation or its operation. One example before

67 S 18 Nuclear Licensing Procedure Ordinance.
68 BVerwGE 72, 300 (308f, 310f) (Wyhl II).
69 ibid 72, 300 (309f).
70 ibid 72, 300 (309).
71 ibid 104, 36 (41).
72 ibid 72, 300 (311f).
73 S 19(3)(n 3) AtG.
74 S 17 (5) AtG.
75 SS 17(1) and (3)(Nr 3), 18(2)(Nr 3) and (3), 19(3) AtG.

the courts was that the operator planned to use plutonium-bearing fuel in a reactor that had hitherto only used fuel without plutonium.[76] Any modification potentially affecting the safety of the NPP must be authorised. In this situation the question arises to what extent the safety of the NPP must be reconsidered at the occasion of the modification authorisation. The conclusion of the courts in these circumstances is that only those parts of the installation have to be adapted to the newest state of the art that are affected by the modification. In the mentioned case this may involve many parts due to the fact that plutonium is particularly dangerous.[77]

A third situation arises, when after the start of operations of the NPP the state of safety technology progresses, new insights into the consequences of emissions emerge, or the installation does not meet the required level of precaution anymore, for instance, because some components are old and worn. In these situations operators can by subsequent orders (*nachträgliche Anordnungen*) be required to take certain curative measures.[78] However, a problem of cost compensation arises in such cases. The operator is required to bear the costs of improvement if a significant danger (*erhebliche Gefahr*) arises and stems from the installation. But if the danger is not 'significant' or if it is due to a change in external circumstances (like, for instance, an increase of planes flying over due to the construction of a nearby airport) the costs of improvement must be compensated from the public budget.[79] Since a significant danger is hard to prove, the authorities are usually at risk of having to pay compensation.

The quest for compensation for subsequent orders was specifically raised against the March 2011 moratorium, in which the Federal Government ordered the shut down of eight old NPPs in the aftermath of 'Fukushima'.[80] A temporary shutdown can in fact be ordered under Article 19(3)(No 3) AtG, and without any compensatory consequences. But this requires that a situation has emerged 'which may constitute a danger to life, health or property'. The Federal Government based its measure on this provision but was challenged by the operators, since 'Fukushima' had not changed the state of German NPPs and the risks they create.[81] The matter was ultimately settled because the three months' administrative moratorium was ended and replaced by legal provisions ordering the permanent stop of the plant operations. This

76 BVerwGE 101, 347.
77 ibid (355 f.).
78 S 17(1)(3) AtG.
79 S 18(2) (Nr. 3)AtG. This duty to compensate privileges NPPs in comparison to other dangerous industrial installations, which according to S 17(1) BImSchG must be adapted to new best available technology without compensation.
80 See (n 31).
81 Manfred Rebentisch, "Kernkraftwerks-Moratorium' versus Rechtsstaat', (2011) 30/9 NVwZ, 533–36.

permanent measure has raised more fundamental questions of constitutionality which are pending at the BVerfG.[82]

3.1.5 Long-term harmful effects

Generally a building for uses that produce waste will not receive a construction permit unless it is proven that the waste can safely be disposed of.[83] Paradoxically, for NPPs—the buildings producing the most dangerous waste—the safe disposal of radioactive waste was not an explicit requirement of authorisation.[84] The licensing authorities have nevertheless used their discretionary powers[85] to take waste disposal into account, but they did this in a very limited way requiring safe disposal for not more than six years.[86] This could be satisfied with the easy proof that intermediate storage of the waste was available for this period.[87] As a final repository for spent fuel has until today not been constructed the ever increasing quantities of it had to be allowed to be stored in intermediate deposits (*Zwischenlagern*) most of which were erected on the site of NPPs.[88] For medium radioactive waste a safe deposit facility is also not available.[89] Another serious shortcoming of the AtG adding up to the flawed handling of waste has been that it did not establish a clear obligation of the operator to dismantle the installation after its closing down and to cover the ensuing costs.[90]

82 See Section 3.2.2.

83 See eg for dangerous installations s 5 (3) n 2 BImSchG.

84 On the political power play behind this decision see Detlev Möller, *Endlagerung radioaktiver Abfälle in der Bundesrepublik Deutschland : administrativ-politische Entscheidungsprozesse zwischen Wirtschaftlichkeit und Sicherheit, zwischen nationaler und internationaler Lösung* (Lang 2009).

85 Fischerhof (n 64) s 7 no 17.

86 The basis for this was an agreement between the Bund and the Länder entitled 'Grundsätze zur Entsorgungsvorsorge für Kernkraftwerke' of 19 March 1980, Bundesanzeiger No 58 of 22 March 1980 and No 63 of 4 April 1989.

87 Kloepfer (n 50) s 15 para 81.

88 Two larger storage facilities exist close to Ahaus in Westphalia and Gorleben in Lower Saxony.

89 The salt dome in the former mine Asse, close to Wolfenbüttel in Lower Saxony, is not safe. Here about 125,000 barrels with low-level and 1,300 barrels with medium-level radioactive waste were stored. Intruding salt water is causing the corrosion of the barrels and the escaping radioactivity can contaminate the groundwater. A costly project is in preparation to recover the waste materials. See *Statusbericht des Niedersächsischen Ministeriums für Umwelt und Klimaschutz über die Schachtanlage Asse* (Niedersächsisches Ministerium für Umwelt und Klimaschutz, 2008).

90 While it has been clarified by law that the operators have to pay for nuclear waste disposal (s 9a(1)(1) AtG), and while they have accumulated significant reserves for this purpose, it remains doubtful whether they are also obliged to dismantle the installations and pay for it. The emerging task and its costs could to a large part become an additional burden to the state. See Wolfgang Cloosters, 'Rückstellungsverpflichtungen für NPP- aus der Sicht einer atomrechtlichen Genehmigungs- und Aufsichtsbehörde' in *13. Deutsches Atomrechtssymposium* (Nomos 2008) 293–306.

3.1.6 Participation in administrative procedures

It is one of the achievements of nuclear energy legislation that it has provided for a rather broad participation of third parties in licensing procedures. Applications and documents have to be made publicly accessible, objections of third parties to be accepted and public hearings with objectors to be conducted.[91] The shadow side of this high level of participation however is the treatment of procedural failures. According to German law not every mistake in the procedure leads to the quashing of the final decision. The mistake must be relevant. Two tests apply in this regard.

The first test requires that a concrete possibility existed that a different decision would have been taken without the procedural mistake.[92] This is especially the case when the facts are complex and the legal provision allows for discretion. While this test is common ground in many national administrative law systems, the second test is particularly Germanic. It requires that the allegedly violated procedural provision grants the claimant an individual right.[93] Older court judgements saw the participation of individuals in administrative procedure as a mere contribution to the quality of the final decision, thus as service in the public and not in the individuals' own interest.[94] This had the consequence that the non-compliance with procedural provisions was not recognised as a violation of individual rights. The BVerfG rejected this doctrine.[95] Based on the constitutional principle that material fundamental rights possess a procedural component, it argued that provisions about participation in procedures serve to protect those persons, whose material fundamental rights are affected by a project, and thus provide an individual right to participate for that reason. The court constructs participation as flanking the material fundamental right of health protection by giving affected persons a voice already in the administrative procedure. Participation is of particular importance when the substance of the material individual right is unclear, because legislation offers discretion to the authorities due to the complexity of the problems at hand. As the dissenting opinion in the *Mühlheim Kärlich* decision of the BVerfG states, in the absence of precise material standards 'it is rather the administrative procedure which is called to producing "reasonable" safety-relevant decisions in the concrete case'.[96]

91 S 7(4)(2) AtG together with s 10(1–4), (6–8) and (10) BImSchG; for details, see Nuclear Licensing Procedure Ordinance as amended and promulgated on 3 February 1995, BGBl. I, 180.

92 S 46 Administrative Procedures Act (VwVfG). Developed in case law since BVerwG, Decision of 30 May 1984, 4 C 58.81, BVerwGE 56, 256 (270), the formula of 'concrete possibility' simplifies the complex wording of the provision.

93 S 42(2) Administrative Courts Act (VwGO).

94 BVerwG, Decision of 14 December 1973, IV C 50.71, BVerwGE 44, 235 (241).

95 BVerfGE 53, 30 (60) (NPP Mülheim-Kärlich); BVerfG, Decision of 26 January 1988, 1 BvR 1561/82 (Zwischenlager Gorleben), BVerfGE 77, 381 (406).

96 BVerfGE 53, 30 (76) (NPP Mülheim-Kärlich). (Author's translation).

The administrative courts followed this doctrine.[97] However, although it was more progressive than the older doctrine because it strengthened the procedural position of individually affected third parties, the linking of procedure with substantive rights had a hampering effect on the participation chances of the general public. The linking to the material individual right follows the model of the citizen as *bourgeois*, who only articulates herself once her own individual interests are affected. This model opposes that of the citizen as *citoyen*, who engages herself politically for the public interest, even if she is not individually harmed.[98] In fact, nuclear energy law does give the general public the right to consult documents, to comment, and to participate in hearings. But according to the said doctrine this right is legally non-actionable for those who are not materially affected. Scholars who seek a constitutional foundation for an actionable right of the *citoyen* point to the principle of democracy.[99] However, prevailing constitutional doctrine in Germany confines this principle to parliamentary representation.[100]

Nonetheless, it is imaginable that even within the framework of the two relevance tests courts could have found authorisations unlawful due to procedural failure because there was a 'concrete possibility' of different outcome and the claimant was materially affected. But courts hardly ever found a procedural mistake to be relevant. There are two reasons for this. One is the general aversion of courts to recognise the intrinsic value of procedures. The German legal tradition trusts in material law rather than in procedures. In a way, the assumption is that a decision can be 'derived' from the subsumption of a case under a legal yardstick rather than being 'made' by participatory dispute.[101] The other reason is the high density of court review. German administrative courts are more inclined than their French or English counterparts to elucidate the deficiencies of the authorities in establishing and assessing the facts. Having heard witnesses and experts, they feel able to come to a definitive decision about the lawfulness of the questioned administrative act. If they do so, there remains no room for assessing procedural failure, because either the administrative act is materially lawful, then the procedural mistake cannot have made a difference, or it is materially unlawful, then to discuss the procedural mistake is superfluous. The situation would be different if the court procedure was not used to replenish the lacunae of administrative investigation but if

97 Explicitly, for instance, BVerwGE 85, 368 (377) (Zwischenlager Gorleben).

98 For these two models, see Rudolf Smend, 'Bürger und Bourgeois', in idem, *Staatsrechtliche Abhandlungen* (Duncker & Humblot 1955) 309–25.

99 Andreas Fisahn, *Demokratie und Öffentlichkeitsbeteiligung* (Mohr Siebeck 2002) 335.

100 Christoph Degenhart, *Kernenergierecht : Schwerpunkte, Entscheidungsstrukturen, Entwicklungslinien* (Heymanns 1981) 206.

101 Fritz Scharpf, *Die politischen Kosten des Rechtsstaats: eine vergleichende Studie der deutschen und amerikanischen Verwaltungskontrollen* (Mohr 1970).

the judges more often used their powers to quash a decision simply for the reason that the authority has elucidated the facts insufficiently.[102] The matter would then have to be referred back to the authority for further clarification.

3.1.7 Standing

German administrative law operates on the basis of a narrow concept of standing.[103] In general, the claimant has standing if she can assert that the opposed administrative act (or its omission) violates one of her individual rights.[104] Sometimes, individual rights are explicitly granted in legislation. More often, however, they must be derived from interpreting the wording of legislation with the help of the so-called protective norm test (*Schutznormtheorie*).[105] This means that a law provides a subjective right, if it requires the authority to engage in or refrain from a certain activity in the interest of individuals (and not only in the interest of the public as a collective), and if the claimant belongs to this group of individuals. In the area of general environmental law courts identify a difference between legal duties to avoid danger and to take precautionary measures.[106] The first is seen to be in the public and individual interest, the latter to be only in the public and not in the individual interest.[107]

In deviation from this general conception the courts have assumed for nuclear law that the precept of precaution also protects individuals possibly affected by radioactive emissions thus conveying them an individual right to precautionary measures.[108] They can, for instance, allege that the NPP will emit radioactivity that leads to a higher actual exposure than permissible under the threshold values, not however, that the dosage is below the limits,[109] unless they substantiate that the limits themselves are based on flawed scientific assumptions.[110] They can also allege that the likelihood of an uncontrolled catastrophic incident is higher than assumed. In that case the radius of possibly affected persons is drawn widely.[111] However, the plaintiff is not heard if she alleges that the licensing authority should take measures which aim at

102 S 113 (3) VwGO.
103 Gerd Winter, 'Individualrechtsschutz im deutschen Umweltrecht unter dem Einfluss des Gemeinschaftsrechts' (1999) 18/5 NVwZ 467–75.
104 S 42(2) German Administrative Court Code (Verwaltungsgerichtsordnung—VwGO).
105 Hartmut Maurer, *Allgemeines Verwaltungsrecht* (18th edn, Beck Verlag 2011) 175.
106 On the difference between the two see Section 3.1.1.
107 cf BVerwG, Decision of 18 May 1982, 7 C 42.80, BVerwGE 65, 313, 320. This theory has met criticism for the fact that precautionary measures of course also protect individuals. In addition, there is the obvious paradox that the more persons are affected the less are acknowledged to have subjective rights. It is also inconsistent with EU law to the extent the latter prescribes precautionary measures to protect the public. See Winter (n 103).
108 cf BVerwG 72, 300 (315) (Wyhl II).
109 BVerwG, Decision of 22 December 1980, 7 C 84.78 (NPP Stade), BVerwGE 61, 256 (264 f).
110 BVerwG, Decision of 21 August 1996, 11 C 9.95 (NPP Krümmel), BVerwGE 101, 347 (351).
111 In one case a claimant lived at a distance of 60 km from the site, see BVerwG, Decision of 11 January 1985, 7 C 74.82, BVerwGE 70, 365 (366).

further reducing residual risk, like for instance mitigation measures in the case of a core meltdown,[112] because residual risk is regarded as to be tolerated by third parties.[113] Neither is there standing concerning the safe disposal of spent fuel if the waste is disposed at another site than at the NPP whose permit is challenged by the claimant, for in that case the claimant is regarded not to be individually affected by the disposal site.[114]

In relation to the stepwise issuing of licences,[115] third parties when appealing against a partial licence could not invoke mistakes of past partial licences and the connected provisional overall assessment if the related term for appeal has passed. This necessitates third parties to file complaint against each partial licence within its specific term of appeal.[116]

In conclusion, the body of regulatory law has reached a high level of doctrinal sophistication and protective strength. This is particularly true for how the precautionary principle was specified, and how care was taken to ensure overall safety given the slicewise construction of NPPs. In many respects however it seriously failed, such as concerning the consideration of alternatives to nuclear energy, the relevance of procedural failure, the need to compensate subsequent adaptation to new states of science and technology, the breadth of standing to sue, and the omission to make the safe disposal of waste and the decommissioning of closed down NPPs a clear precondition of authorisation. These shortcomings may explain why the regulations of NPPs have never really appeased the opponents of nuclear energy.

3.1.8 Liability for damage

As even the most perfect preventative control of risks can fail the law must provide for adequate liability for damage should it occur. In fact, nuclear energy has been subjected to non-fault liability including also *force majeure.*[117] Although the applicable international treaties allow member states to limit the liability, it was made unlimited in Germany.[118] Operators are required to provide financial security, such as by insurance, up to a certain limit which presently amounts to 2.5 billion Euros.[119] The Bund is liable to step in after exhaustion of the security for up to another 2.5 billion Euros while the operator remains liable for all further damage.[120] All this sounds reasonable, but the experience with the immense damage resulting from the catastrophies of

112 See above n 57.
113 BVerwGE 104, 36 (50f).
114 BVerwGE 61, 256 (275); BVerwG, Decision of 22 October 1987, 7 C 4.85 (NPP Brokdorf), BVerwGE 78, 177 (183f).
115 See above Section 3.1.3.
116 S 7b AtG. BVerwGE 92, 185 (192).
117 S 25 AtG in combination with certain international agreements.
118 S 31 AtG.
119 S 13 AtG.
120 S 34 AtG.

Chernobyl and Fukushima has shown that neither the financial security nor the public step-in will suffice to compensate all damage, that the operators will not have sufficient means to cover the rest so that the public budget will finally bear the cost, and that even this will not be enough to fully compensate the many affected individuals.[121]

3.2 Constitutional Law

Opponents and proponents of nuclear power expressed their struggle also in constitutional terms and litigation, arguing that the regulatory law and jurisprudence was not strict enough, or too strict, thus violating their respective basic rights. While this question will become obsolete the more the nuclear exit progresses, the exit itself will remain high on the constitutional agenda for some more years. In addition to the substantive conflict between the right to health protection and the property guarantee, the exit procedure—the striking of a deal between the executive and the regulatees—too became an issue of constitutional controversy. The three topics, health, property and procedure, shall be discussed in turn.

3.2.1 Right to health of third parties

According to Article 2(2)(1) of the German Constitution (Grundgesetz—GG), everyone has a fundamental subjective right to physical integrity. It was established as a 'negative' right defending individuals against state interventions. Case law has developed it further towards an 'objective' duty of the state to protect individuals against harm caused by private actors. This obligation corresponds to a subjective right of affected persons to 'positive' protection measures.[122] This general principle also applies to nuclear law.[123] Hence, individuals have a right to precautionary measures against nuclear risks.[124]

However, this right is of limited practical value because if an individual alleges governmental inaction the courts allow for discretion of the executive, when setting and enforcing technical standards, and even broader discretion,

121 cf Wolf-Georg Schärf, *Europäisches Atomrecht. Recht der Nuklearenergie* (2nd edn, de Gruyter 2012) 65. Realistically, therefore, S 35 AtG provides that if the financial means do not cover the costs they shall be allocated according to critera to be established by law.

122 Bodo Pieroth, Bernhard Schlink, *Grundrechte. Staatsrecht II* (24th edn, C. F. Müller Verlag 2008) 40.

123 BVerfGE 49, 89 (140) (Kalkar).

124 BVerfGE 49, 89 (141). Note that the BVerfG by extending the subjective right to precautionary measures goes beyond a mere right to danger avoidance (on the distinction between the two (see above, Section 3.1.1). This has however not hindered administrative courts to deny an individual right to precaution in other environmental law areas than nuclear law (see n 107).

if legislative action is requested.[125] Moreover, the fundamental right to health of third parties is to be weighed up with the competing fundamental rights to property and free enterprise of operators.[126] Not surprisingly therefore, in no case has a court determined that there was a constitutional obligation of government to step out of nuclear power.

3.2.2 Right to property of operators

Three of the big ESCs (RWE, E.ON and Vattenfall) have started litigation claiming compensation for expropriation at the BVerfG while one—Vattenfall—has in addition asked for dispute resolution by a tribunal of the International Centre for the Settlement of Investment Disputes (ICSID). These cases are yet to be resolved but as the BVerfG and the ICSID tribunals have developed different doctrines concerning the guarantee of property it will be interesting to see if they come to different conclusions. In any case, the judgments will be of crucial importance for nuclear exits in other countries. They may as well have an influence on general environmental policies that fundamentally redefine property positions, such as when profitable land use of farmers is restricted for nature protection reasons or the emission of climate gases is subjected to a regime of auctionable emission rights.[127]

While the detailed motions of the parties are not public, it is useful here to consider the general questions that will inevitably be raised in litigation like this. Thus below, the following questions are explored: whether the nuclear exit violates the guarantee of private property as provided by Article 14 GG and/or Article 13 of the Energy Charter Treaty. The former question is raised in the litigation before the BVerfG and the latter in the case before the ICSID tribunal. The purpose of the following analysis is not to guess the outcome of these cases but to see the type of legal issues that exit raises.

As a first question it must be asked, whether the property guarantee can be applied to the ESCs. The question arises concerning Article 14 GG because according to BVerfG doctrine fundamental rights apply to the relationship between the citizen and the state but not to the relationship between state bodies among each other.[128] It is of no avail in relation to Article 13 Energy Charter which covers both private and public ownership. E.ON and RWE are

125 See for cases concerning noise from airports BVerfG, Decision of 14 January 1981, 1 BvR 612/72 (Düsseldorfer Flughafen), BVerfGE 56, 54; BVerfG, Decision of 4 May 2011, 1 BvR 15/208, 30/16 NVwZ 2011, 991.

126 BVerfGE 53, 30 (57).

127 See further Gerd Winter, 'Rationing the Use of Common Resources: Problems of Design and Constitutionality' in Dawn Oliver, Tony Prosser, Richard Rawlings (eds), *The Regulatory State: Constitutional Implications* (OUP 2010) 129–56 (146).

128 BVerfG, Decision of 8 July 1982, 2 BvR 1187/80 (Sasbach), BVerfGE 61, 82 (101).

mostly in scattered private and public ownership,[129] while Vattenfall is owned by the Swedish state.[130] The question is whether the partial or full public ownership makes the companies part of the sphere of the state so that they cannot rely on the property guarantee.

The BVerfG has never answered this question comprehensively, but in a 1989 Chamber decision it cursorily argued that companies under private law could be attributed to the sphere of the state if they offer 'services of general interest' and are thereby subject to special state supervision.[131] Against this position, it has been argued that the term 'services of general interest' (*Daseinsvorsorge*) is too vague to be the foundation for precise legal differentiation.[132] Instead, it is suggested that the appropriate question to ask is whether there is a considerable amount of private shareholding in a company. The threshold of public shareholding above which the company is attributed to the state is controversial. One would expect it to be 51% but some authors locate it as high as 95% having in mind that any private shareholder must be protected.[133]

Applying this doctrinal controversy to the nuclear exit, according to the functional criterion of public service none of the three ESCs would qualify as holders of the constitutional property guarantee, because all of them provide a public service as energy suppliers. By contrast, according to the structural criterion of ownership Vattenfall would be excluded from property protection and the other two only depending on where the mentioned threshold is located and whether it is exceeded.

If one assumes that the ESCs are allowed to invoke the fundamental right to property, the next question is whether the nuclear exit is an expropriation requiring compensation or a tolerable form of regulation of property use. A short digression into the broader concept of property protection of the BVerfG and the ICSID tribunals is appropriate before an answer to the question can be given. The BVerfG distinguishes between two categories of state interventions into property positions: expropriation (*Enteignung*) and the shaping of the contents and limits of property (*Inhalts- und Schrankenbestimmung des Eigentum)*, or shortly: content determination (*Inhaltsbestimmung*).[134]

129 The precise partition between private and public owners is not publicly available, see <http://www.eon.com/en/investors/stock/shareholder-structure.html> accessed 31 October 2012 and <www.vattenfall.com/en/corporate-governance.htm> accessed 31 October 2012.

130 Vattenfall Europe is owned by Vattenfall AB which again is 100% owned by the Swedish state, ibid.

131 BVerfG 1 BvR 705/88, JZ 1990, 335.

132 Georg Hermes, *Staatliche Infrastrukturverantwortung* (Mohr Siebeck 1998) 91.

133 Erhard Denninger, *Verfassungsrechtliche Fragen des Ausstiegs aus der Nutzung der Kernenergie zur Stromerzeugung* (Nomos 2000) 46; Udo DiFabio, *Der Ausstieg aus der wirtschaftlichen Nutzung der Kernenergie: Europarechtliche und verfassungsrechtliche Vorgaben* (Heymanns 1999) 97.

134 BVerfG, Decision of 15 July 1981, 1 BvL 77/78 (Nassauskiesung), BVerfGE 58, 300 (330).

In relation to the first category, expropriation, the court adheres to a narrow concept: expropriation assumes that a right having economic value is 'taken'.[135] For instance, the taking of a piece of land for the construction of a road is an expropriation. In relation to the nuclear exit the phasing out of NPPs does not transfer or delete the private property in the plant. Therefore, the BVerfG is likely not to consider this to be an expropriation.[136] The second category of intervention, the content determination (*Inhaltsbestimmung*) of property, has three subcategories. One is the normal regulation of property use.[137] It is allowed if it serves a public interest and is proportional. For instance, the prohibition of pollution from industrial installations does not constitute expropriation even if this causes abatement costs. The second subcategory concerns cases where the regulatory impact is extremely burdensome if weighed with the importance of the regulatory objective. Then, it is possible that the proportionality principle suggests that some recompense should be paid (*entschädigungspflichtige Inhaltbestimmung*), the actual amount being flexible and not requiring the full compensation conceived for expropriation.[138] The third subcategory pertains to a situation where the legislator restructures an entire area of sectoral law. It is then allowed to redefine property contents and even to remove existing rights without compensation.[139]

The nuclear exit could be regarded as a normal regulation under the first or second subcategory. This presupposes that the NPPs were not safe anymore. However, given the permanent administrative supervision of the installations this could hardly be proven. The causes of 'Chernobyl' (gross human failure and insufficiently redundant safety measures) and 'Fukushima' (Tsunami, situation of the NPPs at the coast) were rather specific and hardly transferable to German conditions.[140] As noted above the nuclear exit was rather due to a change of risk perception in public opinion and the polity which led to a fundamental reorientation of energy policy.

For such kind of situation the third category is more fitting: If the legislator re-structures an entire legal area for the future, it is first of all authorised to

135 BVerfGE 58, 300 (330).

136 There is nevertheless the possibility that the BVerfG conceives the NPP in its quality as a running business (*ausgeübter Gewerbebetrieb*) to be a property right so that its closing down would be regarded as expropriation. In that direction see DiFabio (n 133) 134; Fritz Ossenbühl, 'Verfassungsrechtliche Probleme des Ausstiegs aus der friedlichen Nutzung der Kernenergie' (1999) 124 AöR 1; Michael Schmidt-Preuß, 'Atomausstieg und Eigentum' (2000) 53 NJW 1524.

137 BVerfGE 58, 300 (330).

138 BVerfG, Decision of 14 July 1981, 1 BvL 24/78 (Pflichtexemplar), BVerfGE 58, 137 (150); fanning out the potential measures that may alleviate the encroachment on property BVerfG, Decision of 2 March 1999, 1 BvL 7/91 (Denkmalschutz), BVerfGE 100, 226 (240).

139 BVerfGE 49, 300 (351).

140 Bernhard Stüer and Sandra Loges, 'Ausstieg aus der Atomenergie zum Nulltarif?' (2000) 19/1 NVwZ 9, however, argue that the phasing out is a case of '*entschädigungspflichtige Inhaltsbestimmung*'.

decide that certain categories of property shall not be accepted.[141] This means for nuclear energy, that the legislator is able to ban property in new NPPs—in other words, to refuse to license new NPPs. In addition, and most importantly in our context, the legislator is allowed to remove existing rights without paying compensation. For instance, in a landmark decision the BVerfG held with regard to old rights to gravel mining that they can be dissolved without compensation, if overriding reasons of public interest (in casu: groundwater protection) exist and the right holders are given a sufficient grace period, which allows them to switch to other economic activities.[142] This concept of dissolution of property rights (*Auflösung von Rechtspositionen*) appears to fit best the change in energy policy presently enacted.[143] It is also likely to be the variant that was assumed by the Federal Government for its phasing out legislation in 2011 because care was taken not to stop operations abruptly but to provide time for the preparing for new fields of investment. Even the eight NPPs that were ordered to close down immediately after the Fukushima accident had been given phase-out time in 2002. It is true that this time was prolonged in 2010, but it is doubtful if such prolongation constitutes a new property position.

In contrast to the property conception of the BVerfG the one adopted by ICSID tribunals appears to provide better chances of compensation for the nuclear exit. Following US property doctrine[144] and based on relevant clauses in bilateral investment agreements as well as—for energy investments—the mentioned Energy Charter,[145] ICSID case law has adopted the concept of 'regulatory' or 'indirect' expropriation alongside the traditional concept of direct taking of property. In a landmark award an ICSID tribunal held that indirect expropriation has two preconditions: that the measure has a serious financial impact rendering an investment utterly unprofitable, and that the impact is

141 BVerfGE 58, 300 (330, 336).

142 BVerfGE 58, 300 (351). In the same line the BVerfG, Decision of 9 January 1991, 1 BvR 929/89 (bergrechtliches Vorkaufsrecht), BVerfGE 83, 201 (211f).

143 Similarly, Gerhard Rollert *Genehmigungsaufhebung und Entschädigung im Atomrecht* (Nomos 1994) 321. Hans-Joachim Koch, 'Der Atomausstieg und der verfassungsrechtliche Schutz des Eigentums' in Bayer and Huber (n 35) 67, 86, 75.

144 Hanri Mostert, 'Does German Law Still Matter? A Few Remarks about the Relevance of Foreign Law in General and German Law in Particular in South African Legal Development with Regard to the Issue of Constructive Expropriation' (2002) 3 German Law Journal <www.germanlawjournal.com/index.php?pageID=11&artID=183> accessed 31 October 2012.

145 Art 13 of the Energy Charter Treaty lays out: 'Investments of Investors of a Contracting Party in the Area of any other Contracting Party shall not be nationalized, expropriated or subjected to a measure or measures having effect equivalent to nationalization or expropriation (hereinafter referred to as "expropriation") except where such expropriation is: (a) for a purpose which is in the public interest; (b) not discriminatory; (c) carried out under due process of law; and (d) accompanied by the payment of prompt, adequate and effective compensation.'

unproportional in relation to the public interest protected by the measure.[146] This somewhat ressembles the second subcategory of content determination (*Inhaltsbestimmung*) in the BVerfG concept, namely the *entschädigungspflichtige Inhaltsbestimmung*, although the latter allows the legislator more discretion not to compensate. There is however no equivalent in the ICSID arbitral awards with the BVerfG third subcategory, ie the phased removal of property positions in the course of reorientation of an entire legal sector. However, it is of course possible that the tribunal develops a new doctrine on the basis of the BVerfG jurisprudence.

It is nevertheless more likely that the ICSID tribunal will consider whether the German nuclear exit is a regulatory or indirect expropriation. Applying the test of serious effects the impact of the nuclear exit is certainly such that the individual plant is rendered completely unprofitable. Furthermore, applying the test of proportionality this impact must be weighed against the public interest at stake which includes the overall change of energy policy. If practicing judicial self-restraint it would adopt an attitude of deference to the legitimate political decision-making of the German legislator. Such respect for democratic political processes is however not akin to the ICSID culture which rather favours investment interests.[147] It is a paradoxical aspect of this case that Germany which as an investor country has often profited from the pro-investment attitude[148] may now become a victim of the same.

3.3 Informal Arrangements and the Separation of Powers

The three exit steps—the limitation of the amount of electricity producible by the individual NPP in 2002, the extension of operating life in 2010 and the

146 *Tecnicas Medioambientales Tecmed SA v The United Mexican States*, ICSID Case No ARB(AF)/00/2 (2003), at No 122; see further Energy Charter Secretariat, *Expropriation Regime under the Energy Charter Treaty*, 2012 <http://www.encharter.org/fileadmin/user.upload/Publications/Expropriation_2012.ENG.pdf> accessed 31 October 2012, where (at 12) the Tecmed case is however wrongly interpreted to only apply the criterion of unprofitability; for a systematic account see A. Newcombe, 'The Boundaries of Regulatory Expropriation in International Law' (2005) 20 ICSID Rev 1.

147 For instance, the tribunal in the Tecmed case was rather hostile against political dynamics when it considered the affected public's protest against a toxic waste site not to be a legitimate public interest in the proportionality test, see ICSID Case No ARB(AF)/00/2 (n 146) at n 127ff. A pro-investment bias of ICSID jurisprudence and its origin in general is substantiated by Pia Eberhardt, Cecilia Olivet, *Profiting from Injustice. How Law Firms, Arbitrators and Financiers are Fuelling an Investment Arbitration Boom* (Corporate Europe Observatory and the Transnational Institute 2012) <http://corporateeurope.org/sites/default/files/publications/Profiting-from-Injustice.pdf> accessed 27 November 2012.

148 Gus van Harten, 'Pro-Investor or Pro-State Bias in Investment-Treaty Arbitration? Forthcoming Study Gives Cause for Concern' in *Investment Treaty News* 13 April 2012 <http://www.iisd.org/itn/2012/> accessed 27 November 2012.

definitive exit in 2011—were all based on prior agreements between the Federal Government and the four major ESCs.

Although these agreements were not meant to be binding contracts their nature as informal understandings has nevertheless raised the question of compatibility with the constitutional principle of parliamentary democracy. It is controversial if the agreements did not undermine the independence of parliamentary law-making. Even though the parliament was not a signatory of the agreements, they were designed to have a factual binding effect allowing a powerful part of the regulatees extraordinary influence on the legislation. For this reason they could be considered to render the resulting parliamentary law void. The contrasting opinion would point to the fact that informal negotiation is intrinsic to politics and that parliament must be construed to take autonomous decisions even if factually bound.[149]

The cited agreements contained not only the political issue of phasing out NPPs but partly also more specific administrative matters concerning individual NPPs. This raised the question if an informal understanding between the Bund government and an ES undermines the constitutional allocation of administrative competences to the Land.[150] The enforcement of nuclear legislation is the competence of *Länder* administration belonging to the category of administration on federal commission.[151] This means that the Federal Government retains far-reaching rights to issue instructions. While the *Länder* have the competence to take externally orientated measures such as issuing permits and supervisory orders (*Wahrnehmungskompetenz*), the *Bund* may issue guidance to the *Länder* as to the content and procedures of those measures (*Sachkompetenz*).[152] The particular case, which was decided by the BVerfG,[153] concerned a clause in the agreement of 2000 on the phasing out of the NPP Biblis A in which the operator of the NPP was freed from taking certain costly improvement measures. This agreed clause was then transformed into an instruction of the Bund to the competent *Land* Hessen to act accordingly. The social-democratic *Land* government which wanted to impose stricter measures appealed against this instruction at the BVerfG alleging that the agreement of the Federal Government with the ES intervened inadmissibly into its *Wahrnehmungskompetenz* and that the instruction was therefore void. A majority of the deciding Senate rejected this argument arguing that it is

149 Cf F. Schorkopf, 'Die 'vereinbarte' Novellierung des Atomgesetzes', (2000) 19/10 NVwZ 1111.
150 Cf Helmut Schulze-Fielitz, *Der informale Verfassungsstaat* (Duncker & Humblot 1984).
151 Arts 85 and 87c GG, s 24 AtG.
152 BVerfG, Decision of 22 May 1990, 2 BvG 1/88 (Schneller Brüter) BVerfGE 81, 310 (333).
153 BVerfG, Decision of 19 February 2002, 2 BvG 2/00 (NPP Biblis), BVerfGE 104, 249ff.

innate to administrative action to strike deals, but two judges stated in a minority decision that by negotiating with the regulatees the Federal Government had unduly set aside the Land competence.[154]

4. Conclusions

Nuclear energy use in Germany has undoubtedly promoted social welfare by producing large quantities of electricity, creating employment, generating exportation opportunities, reducing the emission of greenhouse gases, triggering a regulatory framework that established rather strict safety standards, and provoking a sophisticated constitutional debate on the balancing of the right to precaution and the right to private property. Nuclear energy use has however also caused massive social costs. The financial costs of its development and construction have been heavily subsidized out of public budgets. Safe as it appeared, a bet on the risk of accidents has throughout accompanied the NPPs, a bet that has luckily thus far been won in Germany. Moreover, a heavy burden has been left for many future generations in the forms of radioactive waste and the dismantling of NPPs. The core failure has however been that the nuclear path has diverted finances and technological expertise from renewable resources and energy efficiency measures. The reliance on nuclear energy has dramatically shortened the time period available for a fundamental energy change from fossils to renewables before climate change may cause catastrophic effects. In conclusion it appears that the balance of nuclear energy use is overall negative and the stepping out of it a well-founded solution.

From the outset nuclear energy was accompanied by fierce battles between civil society and the energy sector with their respective political wings. The actual steps into the nuclear exit were clearly pushed by the two catastrophies of Chernobyl and Fukushima. They reinforced the power of critical public opinion. Expertise predicting that nuclear power can be replaced by a new energy policy, and the auspices of the big energy suppliers to invest into renewables created political room for a stepwise but accelerated nuclear exit which was embedded in a more far-reaching reorientation of German energy policy.

The political and economic struggle over the use of nuclear power was reflected in the legal system, in particular in national regulatory and constitutional law, but less so in European and international law. The legal system was able to find compromises between the conflicting interests, and developed standards which contributed to four to five decades of safe performance of

154 BVerfGE 104, 249 (276f).

NPPs. It however was not able to master the more fundamental risks and remaining burdens of nuclear power. The legal system is therefore being developed from controlling nuclear power to phasing it out. It will in particular have to cope with the compensation claims of the ESCs and find solutions for the dangerous leftovers of the NPPs.

Can the German case be a model for nuclear exits in other countries? Hardly so, if it is German exceptionalism (*Sonderweg*). Indeed, some German peculiarities may have played a role. In Germany a scepticism towards high technology is widespread, which ultimately rests perhaps in German Romanticist traditions.[155] However, the negative balance of nuclear energy may well teach also those countries with other socio-economic attitudes. Instigated by the dreadful disasters in the Ukraine and in Japan it has already begun to impress many of them. Hopefully, there is no need for another catastrophe.

155 German Romanticism originated in a cultural movement at the transition from the 18th into the 19th century which, in contrast to the harsh economic-technological world, conceptualised nature not as mechanistic but holistic in the natural sciences, emphasised the inner nature (*Innerlichkeit*) and evolution (*Bildung*) of humans in music and literature, and believed in the ideal rather than practical reason in philosophy. See Peter Watson, *The German Genius: Europe's Third Renaissance, the Scientific Revolution, and the Twentieth Century* (HarperCollins 2010) 65–88, 189–205, 289–310, 830–34.