

NUCLEAR ENERGY IN THE EUROPEAN UNION AFTER FUKUSHIMA: POLITICAL AND ECONOMIC CONSIDERATIONS

DAGMAR KIYAR* AND
BETTINA F. WITTNEBEN**

Introduction

More than one year after the accident at the Fukushima Daiichi nuclear plant in March 2011 the future of nuclear energy is still under heated discussion in Japan – as well as in other parts of the world. After the meltdowns, the European Council (EC) decided to review the safety features of European nuclear power plants. This became known as the ‘stress test’ and applies to all 135 nuclear power plants in the European Union (EU). After an assessment of the seventeen national reports (including 15 EU countries plus Switzerland and the Ukraine), an Action Plan was published in August 2012 containing further activities to improve the safety of the European nuclear power plants.

This decisive action at the EC level belies unified action within the EU. Indeed, the European Union Member States have drawn very different conclusions regarding their national energy policy (Wittneben 2011). Even before Fukushima the role of nuclear energy in climate mitigation and the low carbon economy had been controversial. There was talk of a ‘Nuclear Renaissance’ that was to avert predicted shortcomings in energy supply, improve national energy security and mitigate climate change. This article explores whether such a renaissance has taken place or will take place in Europe, given the policy implications of Fukushima. We outline the status quo of the nuclear energy supply, give policy examples of the UK and Germany and finally

discuss the corporate nuclear strategy examples of RWE and E.ON.

Status quo of nuclear energy within the European Union

Currently, nuclear energy contributes about 27 percent to the European electricity mix¹ and 14 out of 27 European member states run nuclear power plants (IAEA PRIS 2012). Within the Member States the share of nuclear energy in the electricity mix varies widely: the Netherlands only runs one reactor which contributes 3.4 percent to the national electricity mix, whereas France runs 58 reactors that amount to a share of 74.1 percent, making France the world’s largest nuclear power generator on a per capita basis. Table 1 lists the fourteen European member states that currently use nuclear energy for power generation, plus Switzerland and Ukraine as they participated in the EU legislated nuclear stress test after Fukushima. As of August 2012, the current number of reactors in operation within the European Union (EU-27), after Germany decided to permanently shutdown eight of its reactors, is 135. There are currently four reactors under construction in the EU-27 after cancellation of the Bulgarian projects Belene 1 and Belene 2 (each 953 MW(e)) in March 2012 (IAEA PRIS 2012).

The differences in the electricity mix between EU countries are based on past decisions and remain a matter of national sovereignty. However, the European Union is becoming increasingly involved in this decision-making with, for example, EU-wide targets for renewable energies and carbon emission reduction. Since 2009, when the Treaty of Lisbon came into effect, the role of the European Union was strengthened as it is now entitled to ensure the “functioning of the energy market” and “ensure security of energy supply in the Union” (Article 194).²

¹ EU-27: 27.8 percent in 2009, 27.3 percent in 2010, 27.4 percent in 2011 (Eurostat 2012).

² The Treaty on the Functioning of the European Union. Available online: <http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2008:115:0047:0199:EN:PDF>. Further information on the ‘Energy Policy for Europe’: http://europa.eu/legislation_summaries/energy/european_energy_policy/l27067_en.htm.

* Wuppertal Institute for Climate, Environment and Energy, Germany.

** University of Oxford, United Kingdom.



Table 1
Nuclear power reactors in Europe, 2010

Country	Reactors in operation		Reactors under construction		Nuclear electricity supplied in 2010	
	No. of units	Total MW(e)	No. of units	Total MW(e)	TW (e).h	% of total
Belgium	7	5,926	-	-	45.73	51.16
Bulgaria	2	1,906	2	1,906	14.24	33.13
Czech Rep.	6	3,678	-	-	26.44	33.27
Finland	4	2,716	1	1,600	21.89	28.43
France	58	63,130	1	1,600	410.09	74.12
Germany	17	20,490	-	-	133.01	28.38
Hungary	4	1,889	-	-	14.66	42.10
Netherlands	1	482	-	-	3.75	3.38
Romania	2	1,300	-	-	10.70	19.48
Slovakia	4	1,816	2	782	13.54	51.80
Slovenia	1	666	-	-	5.38	37.30
Spain	8	7,514	-	-	59.26	20.09
Sweden	10	9,303	-	-	55.73	38.13
UK	19	10,137	-	-	56.85	15.66
EU-27	143	130,953	6	5,888	871.27	NA
Switzerland	5	3,238	-	-	25.34	38.01
Ukraine	15	13,107	2	1,900	83.95	48.11
Total	163	147,298	8	7,788	980.56	NA

Source: IAEA (2011).

With a view to nuclear energy, the European Union is involved through the Treaty establishing the European Atomic Energy Community (EAEC or Euratom), which was signed in 1957 and has not been revised since. Despite the fact that the treaty is the basis for nuclear safety and radiation protection within the European Union, it has been criticised for its tacit promotion of nuclear energy (Wegener 2007). For example, the treaty emphasises the importance of nuclear power for the European Union: “It shall be the task of the Community to contribute to the raising of the standard of living in the Member States and to the development of relations with the other countries by creating the conditions necessary for the speedy establishment and growth of nuclear industries“ (Article 1) and “recognising that nuclear energy represents an essential resource for the development and invigoration of industry..“ (Preamble) (Euratom Treaty 1957). Besides this “pro-nuclear” aim of the treaty, it has been criticised for its lack of democratic control.³ Nuttall (2009) points to Euratom’s unusual status as all member states of the European Union are parties to Euratom, but it still retains its own legal personality. With regard to criticisms and concerns over a demo-

³ See, for example, the contributions of Marc Johnston (Greenpeace) or Dörte Fouquet (Kuhbier lawyers) to the public hearing on “Assessing Euratom – 50 Years of European Nuclear Policy“, February 2007. Programme available: http://www.europarl.europa.eu/hearings/20070201/itre/programme_en.pdf.

cratic deficit, he points out that unanimity among the member states is needed for a Euratom reform – and this has been lacking in the past (Nuttall 2009). It remains to be seen whether the German phase-out decision and emerging discussions in the German Parliament about the future of the Euratom Treaty will alter the situation.⁴

On the one hand, nuclear energy remains part of the energy future for Europe – for several member states and for the utilities (EURELECTRIC Declaration of 2009⁵). On the other hand, the European Union’s stress tests of its nuclear power plants showed that Fukushima has deeply shaken faith in nuclear energy, even although, arguably, the safety assessments

lacked concrete detail and potential implications as the Commission has no sovereignty over nuclear reactors in its member states (Thomas 2012).

Nuclear Renaissance?

Prior to Fukushima several countries around the world had considered or already invested in new nuclear power plants – a nuclear renaissance was invoked, for example, by the World Nuclear Association. The main drivers were considered to be climate change, as nuclear is considered to have relatively low emission of carbon dioxide, energy security aspects, due to an unstable fossil fuel supply, and an impending electricity generation gap, not least because of upcoming shutdowns of existing nuclear power plants (Goodfellow et al. 2012; Hultman 2011; Greenhalgh and Azapagic 2009). It is questionable, however, whether new nuclear capacity, at least in Europe, can meet these challenges. Bradford compares the existing power plants and ongoing or most recently completed projects: “Most of the world’s reactors are more than 20 years old, so plant completions will be largely offset by retirements” (Bradford

⁴ Motion in the German Bundestag by the Green Party (November 2011), <http://dipbt.bundestag.de/dip21/btd/17/076/1707670.pdf> and the SPD in March 2012 <http://dipbt.bundestag.de/dip21/btd/17/089/1708927.pdf>.

⁵ Available online: <http://www.eurelectric.org/CEO/CEODeclaration.asp>.

2012, 151). He recommends to include nuclear energy in a future electricity mix – but not to “burden it with unnecessary hopes and fears” (ibidem). Similarly, Lovins criticises nuclear energy as the least effective method to save carbon compared to end-use efficiency and renewables (Lovins 2010).

The often so-called ‘Nuclear Renaissance’, much discussed since about 2000, had already faltered prior to Fukushima – at least in the Western countries (Thomas 2012). Reduced investment potential due to the economic crises led to difficulties in attracting investment for nuclear power (Brumfiel 2008) and utilities reconsidered investment decisions because of pessimistic expectations about predicted revenues (Bradford 2012).

If there is a future for the nuclear industry, it is less likely to be in Europe and more likely to be in China, Russia and India (Thomas 2012; The Economist 2012b). In China the nuclear expansion plans are financed by the government and therefore less likely to be affected by economic crises (Brumfiel 2008), whereas in Europe the above mentioned drivers for a nuclear renaissance face an economic obstacle, which resulted in a drop in construction – “a result of the cost of building new plants and the refusal of investors to bear the risks of cancellation, cost overruns and the emergence of cheaper alternatives” (Bradford 2012, 152).

Nevertheless, the drivers for the nuclear renaissance cited above need to be addressed and combined with growing energy demands and it is critical to find answers soon. Furthermore, several states are considering becoming nuclear newcomers, for example, Turkey and the United Arab Emirates.

The impact of the Fukushima accident on European countries

Bradford claims that “Fukushima has shifted the political equation” (Bradford 2012, 152). Analysing the impact of the Fukushima disaster Thomas (2012) distinguishes between four types of reaction:

- Countries with a longstanding “strong anti-nuclear sentiment” like Germany, Switzerland and Italy, which decided to close the option of new reactors and, for Germany and Switzerland, to force the closure of existing plants (as Italy has already closed its nuclear power plants after a referendum in 1987);
- Countries with a nuclear phase-out policy like Spain and Belgium, which had long-term nuclear phase-out policies and which may now experience public pressure to accelerate closure of existing plants;
- Countries such as the Netherlands which may now not proceed with plans for new plants;
- Countries like the UK and France which seem determined to proceed as if the accident in Fukushima has little or no relevance at all.

Nevertheless, Italy, Germany and Sweden, which had already decided on a nuclear phase-out after Three Mile Island and Chernobyl, have reconsidered their decision in the past as concerns over climate change increased, although “the unfavourable economics did not change” (Bradford 2012). Sweden has annulled its Nuclear Phase-Out Act in 2009 and allows the construction of new plants at existing sites.⁶ Germany altered its decommissioning plans and ensured a longer operation for an average of 12 years for its reactors with the Atomic Energy Act in October 2010. In Italy, the Berlusconi government planned to re-enter into nuclear generation and to generate a quarter of its electricity with French-built nuclear plants.

After Fukushima, the German government reversed its decision and after a moratorium, it decided to phase-out eight nuclear plants straightaway and the remaining plants by 2022; the Italian government’s plans to build new nuclear power plants were rejected by a referendum in June 2011.⁷ It remains to be seen how the pending energy supply challenges can be met in these G8 states without nuclear energy.

Example: Germany and the UK

Germany and the UK stand out as examples of the wide spread of policy reactions after Fukushima in March 2011 (Wittneben 2011). Both countries currently generate about one-sixth of their electricity from nuclear energy. The share of nuclear energy in gross electricity generation in Germany was 22.4 percent in 2010 and has now been lowered to 17.6 percent (2011) after the shutdown of eight reactors (AGEB 2012). The share of nuclear energy in net electricity supplied in the UK was 16 percent in 2010

⁶ Regeringskansliet 5. February 2009. Available online: <http://www.sweden.gov.se/content/1/c6/12/00/88/d353dca5.pdf>.

⁷ Further information: BBC News, 14. June 2011. Available online: <http://www.bbc.co.uk/news/world-europe-13741105>.

and 18 percent in 2011 (DECC 2011; DECC 2012) – the growth is due to maintenance outages at several stations in 2010 (DECC 2011).

Both countries have undergone a dramatic change in the last years. In 2003 the UK government was convinced that nuclear power was not economical and that nuclear plants should therefore no longer be built (Greenhalgh and Azapagic 2009). The turn-around came in 2005/2006 when the UK came “from a position of cautious neutrality and a belief that it was neither economically viable, nor ethical until a solution for dealing with radioactive waste was found, to a position of advocacy and encouragement” (Greenhalgh and Azapagic 2009, 1063). This change came with rising concerns about climate change and energy security. Nuclear energy was reframed as a low-carbon technology (Corner et al. 2011). The government in the UK is persevering with its decision that nuclear should be part of the UK’s low-carbon energy mix (BERR 2008a). In 2007 the energy companies were able to register for developing new nuclear power sites (Corner et al. 2011) and in 2008 the government invited energy companies to propose plans for the construction and operation of new nuclear power plants (BERR 2008b).⁸ The conservative UK government decided to build these plants without government subsidies⁹; however, it is not clear whether this will be possible (Bradford 2012; Energy Fair 2012).

In the wake of the Fukushima accident the German government, in August 2011 (Thirteenth act amending the Atomic Energy Act¹⁰), had decided to phase-out its nuclear energy power plants by 2022. The previous coalition of Social Democrats (SPD) and the Green Party had also already decided in 2000 to phase-out nuclear energy by 2023: the Atomic Act (2002) legally secured the agreement between the government and the four nuclear plants operators¹¹, in which the residual operating life of existing nuclear power plants was restricted to 32 years. However, in late 2010 the German government under Chancellor Angela Merkel and her coalition

of Christian Democrats (CDU) and the Free Democratic Party (FDP) changed the course of nuclear energy in Germany and agreed on a lifetime expansion of its reactors by an average of 12 years. After Fukushima this decision was withdrawn and eight nuclear power plants were switched off immediately. The remaining nine reactors are still running for now, with the last one scheduled to be switched off by 2022.

Germany, in the centre of an interconnected European electricity system, has been criticised for this decision with a view to energy costs, energy safety aspects and an expected rise in CO₂ emissions due to fossil power stations – in Germany as well as in the neighbouring states – to fill in the gap. The extent to which this was a socio-political decision or one based on safety concerns is not clear. Nevertheless, it is certain that “Chancellor Angela Merkel faces significant public and political opposition on the issue of German nuclear power...” (Goodfellow et al. 2011, 6208).

Public attitude – the “renaissance of the anti-nuclear movement”¹²?

The political decisions after Fukushima cannot be understood without taking a wider look at different influences that interact with political decision makers. While Germany has a long anti-nuclear tradition (Wittneben 2011), public attitude towards nuclear energy in the UK has been deeply divided for a long time (Corner et al. 2011). While in some studies a “reluctant acceptance“ is ascertained when nuclear energy is positioned as an answer to the climate change challenge (e.g. Bickerstaff et al. 2008), these findings have been put in perspective by other studies. The data supplied by Corner et al. (2011) suggest that public concerns about climate change and about energy security will only raise the acceptance of nuclear energy under very limited circumstances, more precisely if other – preferred – options have been exhausted. The British public is still “relatively divided and uncertain over nuclear power” (Corner et al. 2011, 4830). The research by polling firm Ipsos MORI (2011) supports these findings, showing that roughly half of Britons support (48 percent) and half oppose (51 percent) the use of nuclear energy; 20 percent of those who are against nuclear energy

⁸ Greenhalgh and Azapagic 2009 give a comprehensive overview on the development of UK government policies on nuclear power since 1997. They summarise that within just a few years the government “has moved from a position of neutrality and a cautious ‘let’s wait and see if we need it to an overwhelming surge towards ‘let’s get it done as quickly as possible’ (Greenhalgh and Azapagic 2009, 1055).

⁹ Press Release “Proposals on Liabilities for Nuclear Operators Published”. 24. January 2011, available online: http://www.decc.gov.uk/en/content/cms/news/pn11_007/pn11_007.aspx.

¹⁰ Further information available: Federal Environment Ministry: http://www.bmu.de/english/nuclear_safety/information/doc/4300.php

¹¹ The agreement is available in German: <http://www.bmu.de/files/pdfs/allgemein/application/pdf/atomkonsens.pdf>.

¹² Jochen Stay, “X-Tausendmal quer” Der Spiegel October 2008. available online: <http://www.spiegel.de/international/germany/the-world-from-berlin-the-renaissance-of-the-anti-nuclear-movement-a-589456.html>.

state that their opinion has been influenced by the Fukushima accident (Ipsos MORI 2011).

Public support is one of the most important factors for future technology pathways – not only in the UK, but also in other societies (Corner et al. 2011). Most recently anti-nuclear campaigners have established Japan's first Green Party (Midori no Tō) to offer an alternative to the two main parties that still rely on nuclear power (McCurry 2012). International guests such as Bärbel Höhn (German Green Party) and Scott Ludlam (Australian Greens) took part in the Founding Congress. It remains to be seen what impact these developments will have on the use of nuclear energy in Japan.

Economic impact on energy companies

One driver for the invoked nuclear renaissance is energy security, defined as “the uninterrupted physical availability of energy at a price which is affordable, while respecting environment concerns” (IEA 2012). This shifts the focus to the economic aspects of energy production. Proponents of nuclear power claim it to be cost competitive compared to other forms of electricity generation, especially with regard to its relatively low fuel prices and taking high CO₂ prices into account.

Nevertheless, in recent years and due to the financial crisis, many utility companies have reconsidered new nuclear power plants in deregulated markets – as they have to raise billions from investors to build a new nuclear power plant (Brumfiel 2008). It can be expected that post-Fukushima safety measures might even further raise the price for a new nuclear power plant; Maria van der Hoeven, Executive Director of the IEA, therefore attests that “even with a supportive political attitude, the risk of lower nuclear investment is real” (van der Hoeven 2011).

Thomas (2012) argues that, in the past, high costs for building nuclear power plants were rarely a reason for the failure to obtain finance as electric utilities were monopolies and were thus able to pass the costs to their customers. Since the liberalisation of the electricity market, however, the situation has changed distinctly; since “no nuclear power plant has ever been ordered that would be exposed to a competitive electricity market...” (Thomas 2012, 14). Bradford therefore summarises that the most implacable enemy of nuclear power is not its risk to

public health, but to investors' wallets (Bradford 2012). The Olkiluoto plant in Finland, “the first reactor ever built in a liberalised electricity market” (Thomas et.al. 2007, 5), was seen as a demonstration project to prove the feasibility of a construction in a liberalised electricity market. Initially scheduled to start in May 2009 with originally estimated costs of three billion EUR, the commissioning date was postponed several times; in July 2012 the Finnish utility TVO (Teollisuuden Voima Oyj) estimated that the start may be postponed to 2014 – five years behind schedule.¹³ Based on different calculations the costs may be some two billion EUR (Bradford 2012) or even three to 3.3 billion EUR (Schneider and Froggatt 2012) over budget.

Aside from this difficult investment situation for electricity companies, recent figures for Germany and for the UK document the rising share of renewable energies – a rival low-carbon energy source. According to the latest figures from the Association of German Energy and Water Industries (BDEW), 2012 is another record-breaking year with regard to renewable energies. In the first half of 2012, energy from wind, biomass, solar, hydro, and other renewables amounted to 25.1 percent (BDEW 2012). Similarly impressive figures for the development of renewable energies were published by the Department of Energy and Climate Change (DECC) in July 2012 for the UK, where electricity generated from renewable sources increased in 2011 by 33 percent and accounted for 9.4 percent compared to 6.8 percent in 2010.

Examples RWE and E.ON

RWE and E.ON, Germany's largest electricity utilities, are active both in the German and the British electricity markets. They will thus “need to take a position or attempt to reconcile the different pathways” that the respective national policies are taking (Wittneben 2011, 2).

Before the Fukushima accident the two companies formed a joint venture, Horizon Nuclear Power, with the intention to build new nuclear power plants in the UK. Aside from this consortium two other joint ventures were set up in response to the UK Government's decision to allow for new nuclear power plants in the UK: NNBGenCo (NNB

¹³ Further information available: <http://www.tvo.fi/www/page/3697/>.

Generation Company Limited, a consortium of EDF and Centrica Plc) and NuGen (owned by GDF Suez and Iberdrola). Initially, Scottish and Southern Energy (SSE) held a 25 percent stake in NuGen, but sold its stake to the partners GDF Suez and Iberdrola in February 2012 (NuGen 2012). In March 2012, RWE and E.ON declared their withdrawal from the project Horizon Nuclear Power. As SSE had done before them, the two companies explained that they will concentrate on renewable energies instead (BBC 2012).

RWE explained that it would continue to invest in low-carbon technologies in the UK, as the company already has done with a GBP 1.6 billion investment in gas-fired power stations. E.ON stated that it intends to concentrate on other projects with faster turnaround times than nuclear energy, which requires ten years to start generating power (BBC 2012). Furthermore, E.ON's CEO Johannes Teysen explained that the company "came to the conclusion that investments in renewable, decentralised generation and energy efficiency are more attractive – both for us and for our British customers" (Windpower Monthly 2012). In June 2012, RWE's CEO Peter Terium stated that the company would not only end its activities in nuclear energy in the German and the UK markets, but also worldwide: "The nuclear power chapter has come to an end for us" (Der Spiegel 2012). He explained that this was due to the political decision by the German government. Combined with the rising share of renewables and the economic crisis, this resulted in a sharp decline in electricity prices (Der Spiegel 2012).

Rating agencies welcomed the decision by the German electricity companies. Moody's explained that investment in nuclear energy was risky and that the companies could now focus on less risky projects. The decision therefore was considered 'credit positive' (i-Nuclear 2012). It remains to be seen how the utilities' decisions to retract their bid for building new nuclear power plants will affect UK energy policy.

Renaissance or dead end? Nuclear power in Europe

After taking a look at the status quo of nuclear power in Europe, we concede that the often-cited 'nuclear renaissance' never actually took hold, even before the Fukushima disaster. Hesitant policy commitments to nuclear power were not only due to public concern and local opposition, but also to eco-

nomics aspects, the 'self-limiting' factor. So far, no nuclear power plant has been completed in a liberalised market and examples, such as the continually delayed Olkiluoto plant in Finland, have a cautionary effect on power companies. The European and global economic crises are further intensifying the unwillingness of companies to invest in nuclear power.

Fukushima has exacerbated the problem of financing new nuclear power plants by highlighting the need for higher safety standards and creating a more critical public attitude. Decisions such as the German phase-out have implications on utilities that are operative in other countries as well, as our examples of RWE and E.ON show. At the same time the window of opportunity for a nuclear renaissance was already very limited – due to the rising market share of renewable energies and the declining costs for these technologies.

All eyes are now on Germany's *Energiewende*, as the Economist aptly writes: "The rest of the world watches with wonder, annoyance and anticipatory Schadenfreude" (The Economist 2012a). Will Germany have to rely on its lignite and coal power stations and thus face increased carbon emissions? Perhaps the mechanisms of the EU Emission Trading System can be trusted to ensure that other emissions are lowered. Germany is also at the forefront of increasing the share of renewables in its energy mix. The expertise acquired in renewable energy expansion, together with efforts towards gains in energy efficiency and applying combined heat and power generation, may stimulate the continued growth of these technologies.

That said, it will be equally interesting, or more so, to watch the UK policy situation unfold. Having been let down by three major power companies that had set out to build the new nuclear power facilities, the UK government will be in a poor bargaining position to keep its promise to the British taxpayer not to give concessions to future nuclear power providers. The three challenges that a nuclear renaissance was intended to address – climate change, energy security and rising energy demand – need to be taken seriously. Nuclear power has proven to be too fraught with political and economic barriers to provide an option. Other technologies will have to take its place in the energy mix, or even better, reduce the energy needed through improvements in energy efficiency, to tackle these concerns.

References

- AGEB (2012), Stromerzeugung nach Energieträgern von 1990 bis 2011, Data from February 2012, <http://www.ag-energiebilanzen.de/viewpage.php?idpage=65>.
- BBC (2012), RWE and E.ON halt UK nuclear plans at Wylfa and Oldbury, <http://www.bbc.co.uk/news/world-17546420>.
- BDEW (2012), Erneuerbare Energien liefern mehr als ein Viertel des Stroms, [http://www.bdew.de/internet.nsf/id/20120726-pi-erneuerbare-energien-liefern-mehr-als-ein-viertel-des-stroms-de/\\$file/Strom_Erneuerbaren_Energien_1_Halbjahr_2012.pdf](http://www.bdew.de/internet.nsf/id/20120726-pi-erneuerbare-energien-liefern-mehr-als-ein-viertel-des-stroms-de/$file/Strom_Erneuerbaren_Energien_1_Halbjahr_2012.pdf) (accessed 26 July 2012).
- BERR - Department for Business Enterprise & Regulatory Reform (2008a), Meeting the energy challenge, A White Paper on Nuclear Power, http://www.decc.gov.uk/en/content/cms/meeting_energy/nuclear/new/new.aspx.
- BERR - Department for Business Enterprise & Regulatory Reform (2008b), UK Government invites new Nuclear Power into the energy mix, Press Release, <http://webarchive.nationalarchives.gov.uk/20080205133905/nds.coi.gov.uk/environment/fulldetail.asp?releaseid=343892&newsareaid=2>.
- Bickerstaff, K., I. Lorenzoni, N. Pidgeon, W. Poortinga and P. Simmons (2008), "Reframing nuclear power in the UK energy debate: nuclear power, climate change mitigation and radioactive waste", *Public Understanding of Science* 17, 145–169.
- Bradford, P. (2012), "The nuclear landscape", *Nature* 483, 151–152.
- Brumfiel, G. (2008), "Nuclear renaissance plans hit by financial crises", *Nature* 456, 286–287.
- Corner, A., D. Venables, A. Spence, W. Poortinga, C. Demski and N. Pidgeon (2011), "Nuclear power, climate change and energy security: Exploring British public attitudes", *Energy Policy* 39, 4823–4833.
- DECC - Department of Energy and Climate Change (2011), Digest of UK Energy Statistics (DUKES), <http://www.decc.gov.uk/assets/decc/11/stats/publications/dukes/2307-dukes-2011-chapter-5-electricity.pdf>.
- DECC - Department of Energy and Climate Change (2012), Digest of UK Energy Statistics, Statistical Press Release, <http://www.decc.gov.uk/assets/decc/11/stats/publications/dukes/5991-statistical-press-release-dukes-2012.pdf>.
- Der Spiegel (2012), The Nuclear Power Chapter Has Come to an End, <http://www.spiegel.de/international/business/rwe-s-new-ceorium-to-halt-nuclear-power-and-invest-in-renewables-a-841260.html>.
- Energy Fair (2012), Nuclear subsidies, http://www.mng.org.uk/gh/private/nuclear_subsidies1.pdf.
- Euratom Treaty (1957), <http://eur-lex.europa.eu/en/treaties/dat/12006A/12006A.htm>.
- Eurostat (2012), Electricity production and supply statistics, data from June 2012, http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Electricity_production_and_supply_statistics and http://epp.eurostat.ec.europa.eu/statistics_explained/images/f/f6/Electricity_Statistics%2C_2011_%28in_GWh%29.png.
- Goodfellow, M. J., H. R. Williams and A. Azapagic (2011), "Nuclear renaissance, public perception and design criteria: An exploratory review", *Energy Policy* 39, 6199–6210.
- Greenhalgh, C. and A. Azapagic, (2009), "Review of drivers and barriers for nuclear power in the UK", *Environmental Science and Policy* 12(7), 1052–1067.
- Hultman, N. E. (2011), "The political Economy of nuclear energy", *Wiley Interdisciplinary Review: Climate Change*, 2(3), 397–411, http://onlinelibrary.wiley.com/store/10.1002/wcc.113/asset/113_ft.pdf?v=1&t=h53xixz6&s=5afb44dda13156459f426d87b32587547debe31c.
- IAEA (2011), *Nuclear Power Reactors in the World*, 2011 Edition, <http://www-pub.iaea.org/books/iaeabooks/8752/Nuclear-Power-Reactors-in-the-World-2011-Edition>.
- IAEA (2012), *Nuclear Power Reactors in the World*, 2012 Edition, <http://www-pub.iaea.org/books/IAEABooks/8945/Nuclear-Power-Reactors-in-the-World-2012-Edition>.
- IAEA PRIS (2012), Power Reactor Information System, <http://www.iaea.org/pris/>.
- IEA (2012), Energy security, http://www.iea.org/subjectqueries/keyresult.asp?KEYWORD_ID=4103.
- i-Nuclear (2012), Moody's says German withdrawal 'credit positive'; decision gives EDF bargaining power, <http://www.i-nuclear.com/2012/04/02/moodys-says-german-withdrawal-credit-positive-decision-gives-edf-bargaining-power/>.
- Ipsos MORI (2011), Global Citizen Reaction to the Fukushima Nuclear Plant Disaster, Global @visor, <http://www.ipsos-mori.com/Assets/Docs/Polls/ipsos-global-advisor-nuclear-power-june-2011.pdf>.
- Lovins, A. B. (2010), "Proliferation, Oil, And Climate: Solving For Pattern", *Foreign Policy*, http://www.foreignpolicy.com/articles/2010/01/21/a_roadmap_to_our_energy_future?page=full.
- McCurry, J. (2012), Anti-nuclear campaigners launch Japan's first green party, *The Guardian*, <http://www.guardian.co.uk/environment/2012/jul/30/japan-green-party-nuclear-power>.
- NuGen (2012), NuGen's purchase of SSE's 25 percent stake is complete, Press Release, http://www.nugeneration.com/download/NuGen_25percent_share.pdf.
- Nuttall, W. (2009), "Euratom reform has part to play in EU's energy policy plans", *Research Europe* 287, p. 8. http://www.eprg.group.cam.ac.uk/wp-content/uploads/2009/10/nuttall_re-284-editorial-pages.pdf
- Schneider, M. and A. Froggatt with J. Hazemann, (2012), "World Nuclear Industry Status Report 2012", Paris, <http://www.worldnuclearreport.org/IMG/pdf/2012MSC-WorldNuclearReport-EN-V2-LQ.pdf>.
- The Economist (2012a), Energiewende, <http://www.economist.com/node/21559667>.
- The Economist (2012b), The dream that failed. A year after Fukushima, the future for nuclear power is not bright – for reasons of cost as much as safety, <http://www.economist.com/node/21549936>.
- Thomas, S. (2012), "What will the Fukushima disaster change?" *Energy Policy* 45, 12–17.
- Thomas, S., P. Bradford, A. Froggatt, and D. Milborrow (2007), "The economics of nuclear power", Greenpeace Research Report, <http://www.greenpeace.org/international/Global/international/planet-2/report/2007/12/the-economics-of-nuclear-power.pdf>.
- Van der Hoeven, M. (2011), "The IEA and Electricity Security After Fukushima", IEA news speech, <http://www.iea.org/newsroomandevents/speeches/nea.pdf>.
- Wegener, B. W. (2007), "Die Kündigung des Vertrages zur Gründung der Europäischen Atomgemeinschaft (EURATOM). Europa-, völker- und verfassungsrechtliche Optionen der Bundesrepublik Deutschland", Green Party Germany, http://www.gruene-bundestag.de/fileadmin/media/_archivextern/ein_euratomausstieg_ist_moeglich_und_noe/euratom_gutachten_im_auftrag_der_bundest.pdf.
- Windpower Monthly (2012), E.ON confirms strategy focused on renewables, <http://www.windpowermonthly.com/news/1124937/Eon-confirms-strategy-focused-renewables/>.
- Witneben, B. F. (2011), "The impact of the Fukushima nuclear accident on European energy policy", *Environmental Science & Policy* 15, 1–3.