Fukushima and German Energy Policy 2005 – 2015/2016

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EWI Working Paper, No 19/02

January 2019

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ISSN: 1862-3808

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Abstract: The Fukushima Daiichi nuclear accident in 2011 led to some drastic reactions in Germany, in particular an immediate shut-down of older nuclear power plants. This event is therefore often seen as a turning point, or a major accelerator for the German *Energiewende*. We investigate the short term effects, but also put the event into a longer, 10-year perspective. This shows that hardly any trend in the energy policy was strongly affected by policy decisions of 2011. Major trends are the increase of renewable electricity sources, the phase out of nuclear, a slight increase in energy efficiency, while total energy consumption and also greenhouse gas emissions remained stable in the decade 2005-2015/16. We also provide some tentative explanations for these developments.

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* A revised version of this paper is forthcoming in Marc Ozawa et.al. (eds.), Good Energy Policy, Cambridge University Press.

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The immediate effect of Fukushima[1]

The political consequences

On March 11, 2011, an earthquake in the Pacific Ocean caused a tsunami which hit the Japanese coast. This tidal wave caused severe damage at the nuclear power plant Fukushima Daiichi, operated by the Tokyo Electric Power Company (TEPCO). As a result, large amounts of radioactive material were emitted into the environment. [2]

Though without any direct effect on Europe, this tragic accident at the (literally) opposite side of the globe triggered strong reactions in the German energy policy debate. It led to an accelerated phase-out of nuclear power in Germany, with decommissioning of the last plants by 2022 and an immediate shutdown of Germany's seven oldest nuclear power plants on 14 March 2011.

In Germany, the controversy over the use of nuclear power in the electricity system had been long and fierce. Resistance against nuclear power was one of the founding elements and building blocks of the Green Party in Germany in the 1970s. Support for environmental issues, but in particular the fight against nuclear power, allowed this political movement to enter the previously extremely stable German political party landscape. Since the early days of the German Federal Republic in the 1950s, Germany was essentially a three-party system, with two large parties, Conservatives (CDU) and Social Democrats (SPD) and a small liberal party (FDP). The Conservatives and Liberals held, by and large, positive views of nuclear power. By contrast, the SPD had sought the decommissioning of some nuclear power plants ever since the Chernobyl accident in 1986.

Just prior to the Fukushima accident, in 2010, the then-ruling Conservative-Liberal government had prolonged the use of nuclear power. It granted a life extension of more than ten years for newer nuclear power plants.[3] In doing so, the government overruled its predecessor's faster phase-out plans. In 2000, a coalition of the Social Democratic Party and Green Party had established a 'nuclear consensus' with the nuclear power plant operators, which meant a decommissioning of all nuclear power plants by the early 2020s.[4] The coalition of Social Democrats and Conservatives, ruling from 2005 to 2009, did not change this plan. However, overruling the 'nuclear consensus' and prolonging nuclear power use had explicitly been a core element of the Conservatives' political campaign in the 2009 election, which they had won and which had also put the Conservative-Liberal government in office at the time of the Fukushima accident.

Fukushima drastically changed the Conservative-Liberal government's view on nuclear power, in particular the position held by Chancellor Merkel. As a reaction to the events of Fukushima on 11 March 2011, the government, anticipating a strong revival of anti-nuclear sentiments, and facing an important election in one of the federal states (Baden-Württemberg), was quick to revise its nuclear power-friendly position. Within three days after the Fukushima accident, by 14 March, the Conservative-Liberal government established a three-month 'Moratorium on nuclear power' to evaluate and reflect on the risks of this technology. This meant the immediate shutdown of the 5 GW

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[1] The following is partly based on: Christian Growitsch and Felix Höffler, Impact of Fukushima on the German Energy Policy Debate, IAEE Policy Brief 4/2011, p. 13-15.

[2] Official report of the Fukushima Nuclear Accident Independent Investigation Commission (NAIIC Report), 2012, p. 12-14.

[3] 11. Gesetz zur Änderung des Atomgesetzes, 8. Dezember 2010, Bundesgesetzblatt Jg. 2010, Teil I, Nr. 62, 1814-1816.

[4] For the background on the phase-out plans of the SPD-Green government see for instance Miina Kaarkoski, Energiemix versus *Energiewende*. Competing Conceptualisations of Nuclear Energy Policy in the German Parliamentary Debate of 1991-2001, Jyväskylä Studies in Humanities 290, Jyvsäskylä 2016, p. 60-67.

generation capacity of older nuclear plants (another 3.5 GW of nuclear capacity was not running due to technical revisions).

On 6 June, even before the end of the moratorium (planned for three months, i.e., up to 14 June), the very same government that had overruled the phase-out plans of its leftist predecessors now committed to an accelerated phase-out. The government now proposed (again) a total decommissioning by 2022. Due to Fukushima, nuclear power lost the support of all main political parties and the overall German population.

Short-term market and quantity reactions

Before the Fukushima accident, nuclear was a very important component of German electricity generation. In 2010, 22 % (140 TWh) of the German electricity generation stemmed from nuclear power plants. There was an installed nuclear capacity of 21.5 GW, 13 % of a total installed capacity of 171 GW in 2010 (Figure 1). Hence, the moratorium affected a significant part of total power generation: almost a quarter of all nuclear installations had to be shut down immediately.

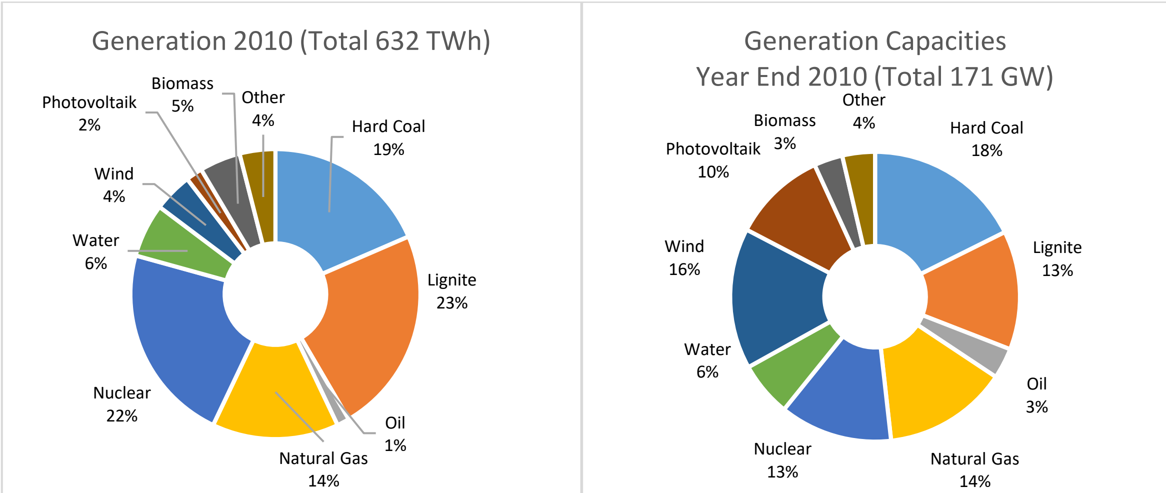


Figure 1: Electricity Generation and Capacity 2010.[5]

The shutdown of 5 GW nuclear capacity by March 14th, 2011 was completely unexpected and constitutes a textbook example of a negative supply shock. It is therefore interesting to investigate how the markets reacted to this shock. Thoenes[6] shows that the markets reacted quickly, and correctly anticipated that the decommissioned power plants would not come back and that the accelerated nuclear phase-out was irrevocable.

Since short-term electricity prices are highly volatile, it is unsurprising that for the day-ahead prices an effect of Fukushima is hardly discernable. Figure 2 (left) depicts the day-ahead base and peak price at the German electricity exchange before and after the announcement of the memorandum.

[5] Source: BMWi. Zahlen und Fakten. Energiedaten. Last updated October 4th, 2017. (Energy data published by the German Federal Ministry of Economic Affairs and Energy). https://www.bmwi.de/Redaktion/EN/Artikel/Energy/energiedaten.html.

[6] Thoenes, Stefan: Understanding the Determinants of Electricity Prices and the Impact of the German Nuclear Moratorium. *Energy Journal*, Vol. 35 (4), 2014.

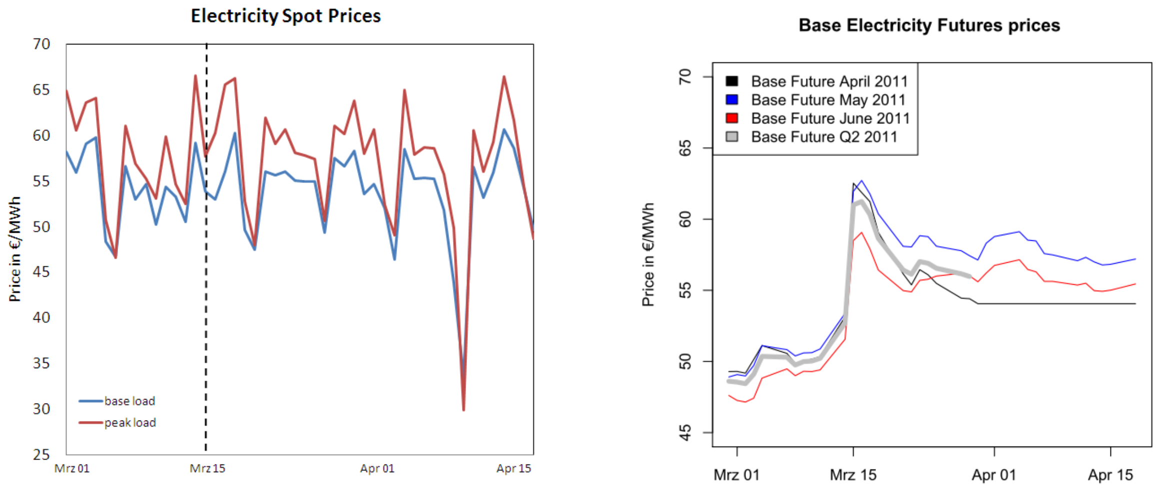


Figure 2: Electricity Prices[7]

While it is harder to identify price increases in the spot market,[8] Figure 2 (right) immediately reveals that future prices reacted. At the German electricity exchange, future prices increased sharply and – after some "overshooting" – stayed on a significantly higher level than before the moratorium.

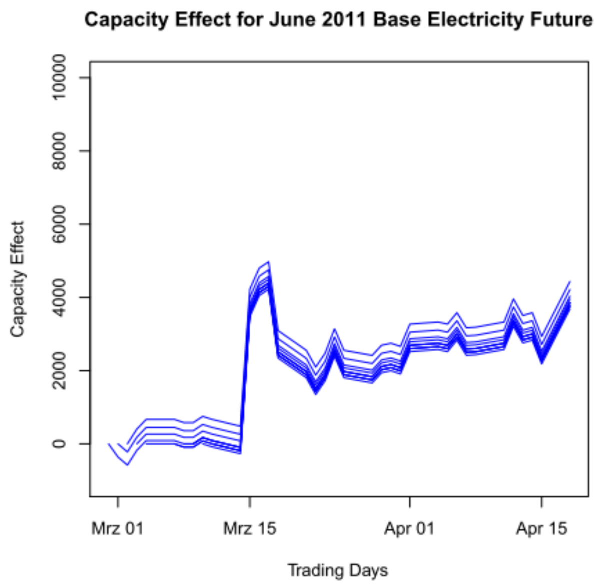


Figure 3: Capacity Effects (in MW) for June 2011[9]

Did the markets expect that the moratorium was only transitory and that the 5 GW capacity would come back to the market? Or did they immediately foresee that the U-turn of the conservative government regarding nuclear was irreversible? Figure 3 elicits from the market prices the quantity effects which the market expected.[10] Based on semiparametric estimations of the relation between demand and supply (i.e., the merit order), it essentially simulates which quantity reductions would be in line with the observed price changes in the futures market. It illustrates which changes in the merit order due to reductions of nuclear capacity would support the price changes of Figure 3. This is called

[7] Source: European Electricity Exchange (EEX).
[8] Grossi et. al. (2017) show that indeed the supply reduction had the expected price-increasing effect on the spot market. (Grossi, Luigi, Heim, Sven, and Waterson, Michael: The impact of the German response to the Fukushima earthquake, *Energy Economics* 66 (2017), 450-465.)
[9] Thoenes (2011), p. 24. The different lines correspond to different Futures, issued between February 28 (the one starting to the very left), up to March 4.
[10] See also Thoenes (2014), p. 69-75 for the derivation and discussion of the capacity effect.

the 'capacity effect' (in MW). It shows that the market immediately accounted for the reduction of the 5 GW (5.000 MW) capacity but quickly adjusted to a level of about 3 GW. This reflects that the market (correctly) anticipated that part of the withdrawn nuclear capacity was to be replaced by fossil power plants and imports. Looking at long-term expectations beyond the end of the moratorium in June 2011, Figure 4 (which depicts the futures for the fourth quarter of 2011) shows that the market anticipated that the nuclear capacity would not come back, but that the capacity effect remained stable at about 3 GW.

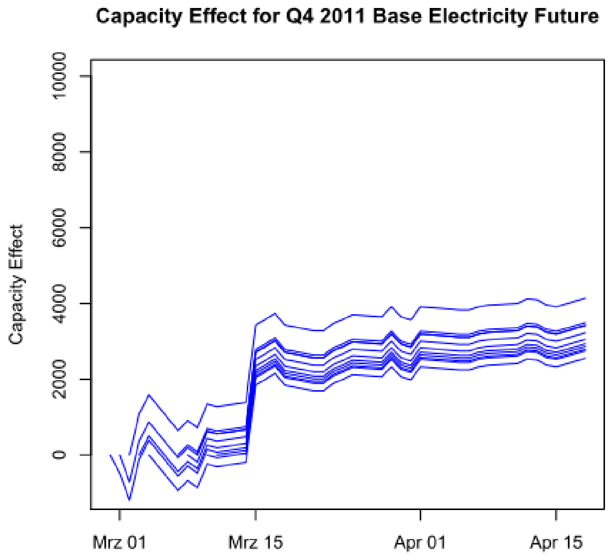


Figure 4:Capacity Effect (in MW) for after the end of the moratorium[11]

That cutting off supply from 5 GW baseload capacity did not destabilize the electricity system in Germany is to a large extent due to the strong interconnection of the electricity grid in continental Europe. Imports quickly increased as a reaction to the moratorium. Figure 5 highlights that soon after the moratorium, Germany became a net importer of electricity, reaching a local net import maximum by May 2011. This atypical constellation continued well into autumn 2011. A closer look into the data reveals that France and the Czech Republic had increased their exports to Germany, while German exports to Austria, Poland, Swiss and the Netherlands had declined.

[11] Thoenes (2011), p. 24. The different lines correspond to futures issued on different days, starting February 28.

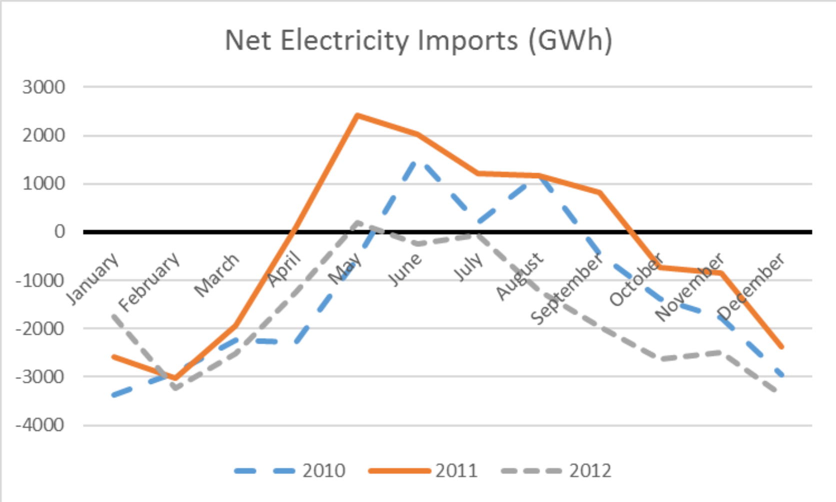


Figure 5: Electricity Exports and Imports[12]

Figure 5 also illustrates that the substitution of nuclear by imports was only a temporary phenomenon. Net imports came back to (or even below) pre-Fukushima levels by 2012. The reason was a national fuel switch. By comparing pre- and post-Fukushima fuel mixes, Figure 6 shows that the significant cut back in nuclear generation (41 TWh of 629 TWh total generation, i.e., 7 % of total generation) was compensated by various domestic sources, while total generation stayed almost constant. Lignite directly substituted nuclear baseload generation (+ 15 TWh), and also renewables increased significantly (by a total of 37 TWh). The decrease in generation from natural gas is to a large extent due to the increase in the gas price by 40%;[13] however, gas generation never regained pre-Fukushima levels, an indication of merit order effects due to increased renewable production, discussed in section 3.

[12] Source: Destatis, GENESIS Datenbank, Monatsberichte über die Elektrizitätsversorgung, 43311-0003, Ein- und Ausfuhr von Elektrizität, (German Statistical Office, Monthly Reports on Electricity Supply, Imports and Exports) https://www-genesis.destatis.de/genesis/online/data;jsessionid=DBAFDCA2FCEC2C9D82155AE7FC12CC41.tomcat_GO_1_1?operation=statistikAbruftabellen&levelindex=0&levelid=1496249610018&index=4 .

[13] The average import price for gas ('Grenzübergangspreis') increased from 5,7 €/Tj in 2010 to 8,1 €/TJ in 2012. Source: Bundesamt für Wirtschaft und Ausfuhrkontrolle, BAFA, (Federal Office for Economic Affairs and Export Control), http://www.bafa.de/DE/Energie/Rohstoffe/Erdgas/erdgas_node.html

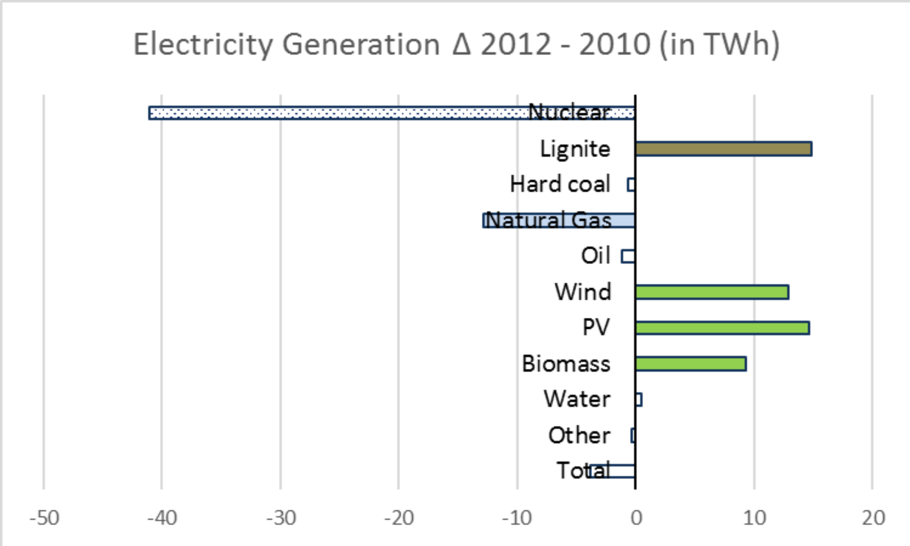


Figure 6: Change of fuel mix 2010 - 2012[14]

Long term effects of the accelerated phase out

The federal government reacted to Fukushima not only with the moratorium on nuclear power, but also published a new ‘energy concept’ on 6 June 2011.[15] In thirty-nine paragraphs the document describes adjustments to the German energy policy in reaction to Fukushima. It starts out with the aim of an accelerated decommissioning of nuclear power plants (§ 3) and supporting measures to ensure short-term generation adequacy. The concept paper also includes many other topics and policy aims, like reducing greenhouse gas emissions by 40 % in 2020 (compared to 1990).

Most notably, the proposal defines as a cornerstone a rapid expansion of renewable energy sources (§ 11). Though the text starts by speaking generally of renewable energy, almost all subsequent measures and initiatives refer to the electricity sector. For instance, the ’energy concept’ sets forth an explicit target for the maximum fee for financing renewable electricity sources, which should not exceed 3.5 €-cent/kWh for household customers (§ 12). Important targets and areas of activity named in the concept paper include electricity grid expansion, and energy savings in the housing sector. Eight legal acts were initiated by the energy concept in June 2011.

Nothing of the 2011 energy concept was fundamentally new. Clearly, the decommissioning of nuclear power was accelerated, though essentially only brought back to the phase-out trajectory that was previously negotiated in 2000 by the leftist government in the ‘nuclear consensus’ with the energy industry. However, the ‘energy concept’ stabilized the political energy agenda. Although the ‘energy concept’ has seen various adjustments, the core elements are still guidelines for the German energy policy and monitored biannually by a standing committee of energy market experts. Still, the core elements are:

1) Decommissioning of all nuclear power plants by 2022;

2) Increasing the share of renewables in electricity generation (2017 target: 40–45 % by 2025);

3) Reduction of greenhouse gas emissions (2017 target: by 40 % in 2020, compared to 1990); and

4) Reduction in primary energy consumption (2017 target: by 20 % by 2020, compared to 2008).

[14] BMWi. Energiedaten. Table 22.

[15] BWMi, Der Weg zur Energie der Zukunft. www.bmwi.de/Redaktion/DE/Downloads/E/energiekonzept-2010-beschluesse-juni-2011.html.

The part of the German energy system that has changed most in the last one to two decades is clearly the electricity sector. The generation mix nowadays differs substantially from that before Fukushima. Nuclear power has been substituted mainly by lignite as a base-load technology. The enormous increase in renewable electricity sources[16] has, whenever available, driven the most expensive technologies (in the sense of variable cost), namely gas and, in part, hard coal, out of the merit order, see Figure 7.

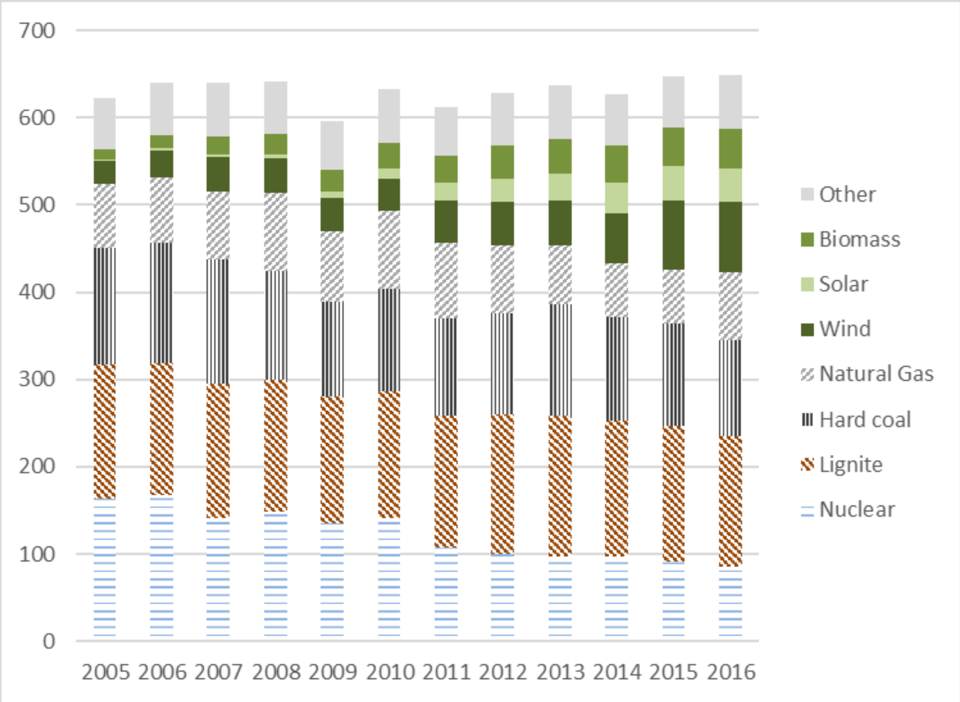


Figure 7: Gross electricity generation (TWh)[17]

However, these changes had already started well before 2011. Nuclear power was already on the decline, and renewables already had increased significantly before 2011. Nevertheless, the growth rate increased after 2011, to a large extent driven by solar energy. In the five years before Fukushima (2006–2011), the share of renewables in electricity consumption[18] increased on average by 1.8 percentage points p.a., while the increase from 2011 to 2016 was on average 2.3 percentage points p.a.[19] Figure 11.8 shows renewable capacities and their share in overall electricity generation from 2005 to 2016. Wind installation doubled, and PV capacity increased by a factor of almost twenty. Total renewable electricity capacities tripled in this decade, and so did the share in total electricity generation.

[16] Wind, solar and biomass accounted for 6 % in 2005 and 25 % by 2016 of gross German electricity production.
[17] BMWi, Table 22.
[18] This refers to the figures reported by the federal government for its (current) target of 35 to 40 % share of renewables by 2025. It divides gross domestic electricity generation from renewables by gross domestic *consumption* of electricity. Germany is a net exporter of electricity (8.6 % of total generation exported in 2016), in particular in hours with high renewable generation (and hence low German prices). Therefore, this figure does not really measure 'how green' is the electricity consumed in Germany.
[19] BMWi, Energiedaten, Table 22.

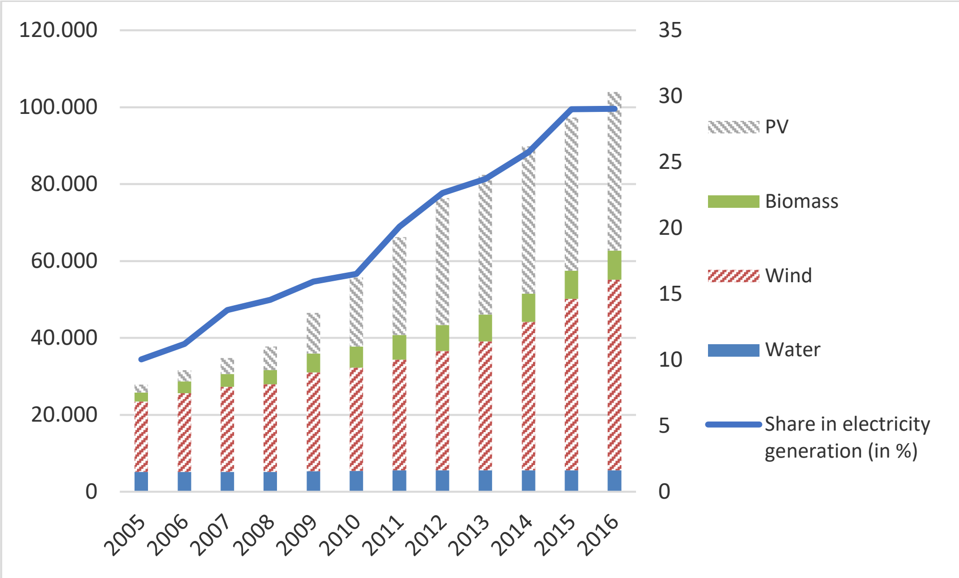
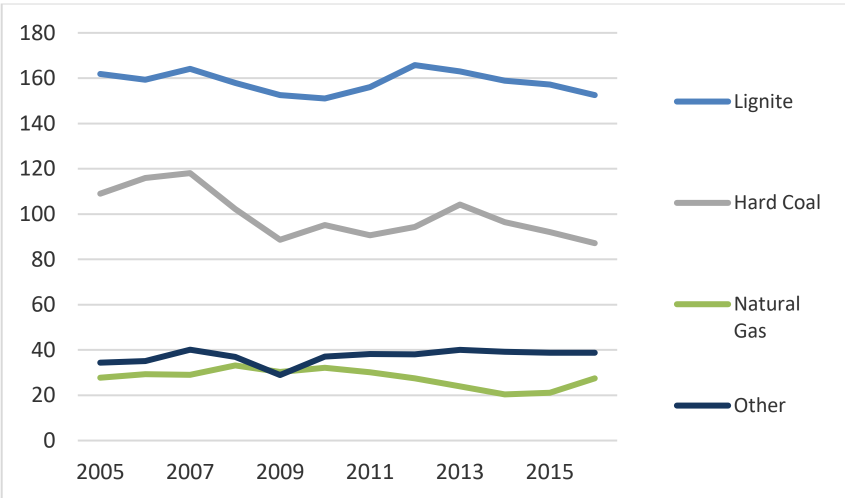


Figure 8: Renewable electricity capacities (in MW)[20]

While the generation mix significantly changed, overall electricity generation stayed roughly constant at 600–650 TWh (consumption: about 530 TWh[21]) for the period 2005–2016. Within the generation mix, lignite generation was stable at about 150 TWh, and also hard coal remained constant at about 110 TWh since 2009, while natural gas, peaking at 89 TWh in 2010, has been declining since then.

The sum of different changes in the generation mix (much more renewables, less nuclear power and gas, stable coal) explains why despite the sharp increase in renewables, the CO2 emissions from electricity generation remained almost unchanged for the whole decade at a bit more than 300 mt CO2 p.a. A slight decrease of 5 to 10 % took place, but this occurred primarily in the five years before 2011.



Total (mn t CO_2): 333 351 301 315 331 309

Figure 9: CO_2 Emissions from electricity generation (in mn t CO_2)[22]

While CO2 emissions from the electricity sector decreased only slightly in the last decade (and not at all since Fukushima), overall emissions, i.e., from all sectors (including electricity) did. Figure 10 illustrates a decrease of total greenhouse gas emissions, particularly in the five years before

[20] BMWi, Energiedaten, Table 20.
[21] Net of network losses and self-consumption. BMWi, Energiedaten, Table 21.
[22] BMWi, Energiedaten, Table 11.

Fukushima. The decrease stems mainly from the energy sector (-60 mt CO2 equivalent), with contributions from the energy industry (-27 mt) and the industrial sector (-10 mt), where these reductions certainly reflect the economic downturn after the global financial crisis. The household sector reduced emissions by -23 mt, mainly due to more efficient heating and insulation. Little changed after 2011 in terms of overall emissions.

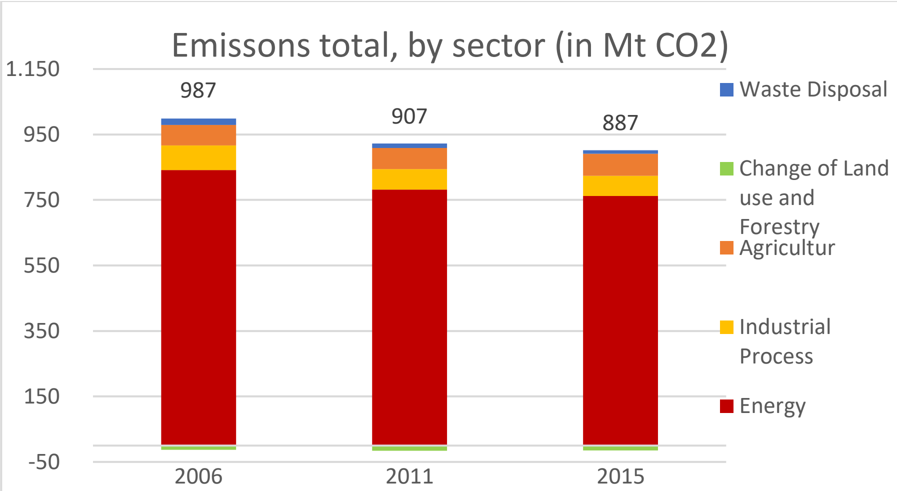


Figure 10: Total CO2 Emissions (in mn t CO2 equivalent)23

While Germany saw (moderate) real growth in the period after Fukushima (+ 1.2 % GDP p.a. from 2011 to 2016), total energy consumption stayed almost constant (+ 0.6 % p.a. from 2011 to 2016) in this period. It had decreased in the five years before Fukushima, mainly due to less energy consumption in the housing sector (Figure 11).

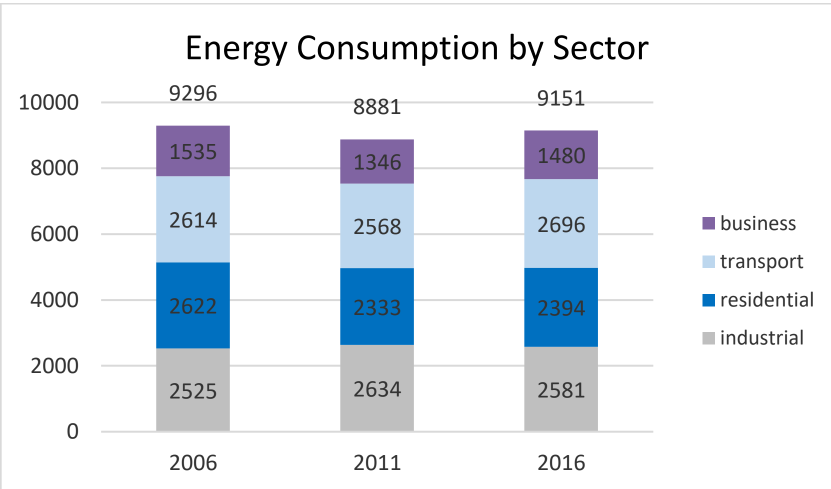


Figure 11: Primary Energy Consumption (in PJ)[24]

As a result, energy intensity, and also emissions intensity kept on declining after 2011, though at a slightly lower rate (Figure 11.12, (left). Electricity intensity reduced from 0,23 kWh/€ GDP in 2006 to 0,174 kWh/€ GDP in 2015 (-22 %). Again, all of this reflects long-term trends in which 2011 does not feature prominently.

[2323] BMWi, Energiedaten, Table 10. The data in this data source are not fully consistent with the data for Figure 9 (which are based on Table 11) due to different calculation methods and conversion factors. See the footnote for Table 11 in the data source.

[24] BMWi, Energiedaten, Table 6a.

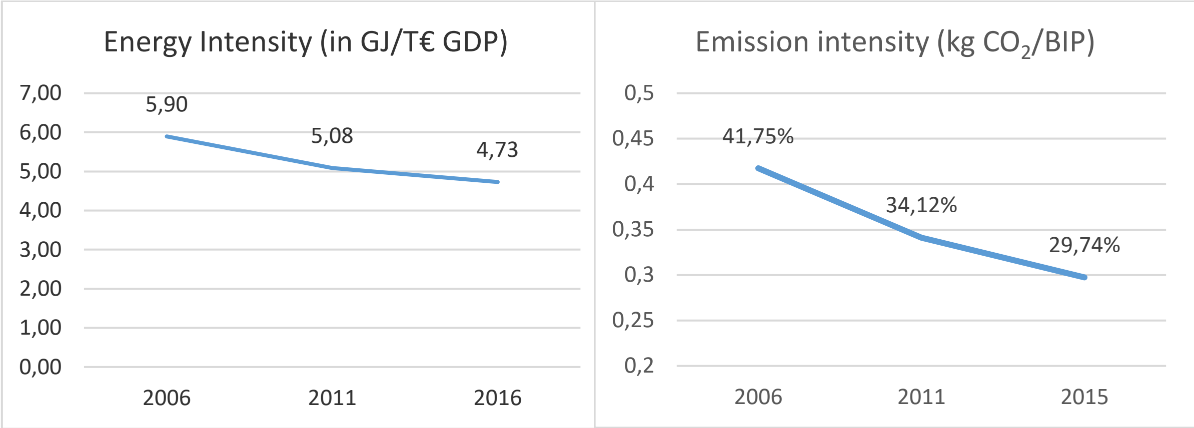


Figure 12: Energy intensity and emission intensity[25]

One might expect that the policy change may have had a significant effect on the business model of the (incumbent) energy companies. Indeed, the four major incumbent companies have undergone dramatic changes. For instance E.ON, which had been the largest German energy company, has actually split its business into an incumbent part (including all conventional generation assets) and a 'new' E.ON company, focusing on renewables, trade and services.[26] The two major players, RWE and E.ON, faced a dramatic loss in stock market value after Fukushima. From 2011 to 2016 each of the two companies lost about 60 % of its market capitalization, a combined loss in value of 28 bn €.

However, taking a long-term perspective reveals that the year 2011 does not appear as a turning point. Figure 13 illustrates that both German energy incumbents already had lost value pre-2011, and performed significantly worse than energy industry indices, or the stock market on average (Euro Stoxx, or the German DAX).

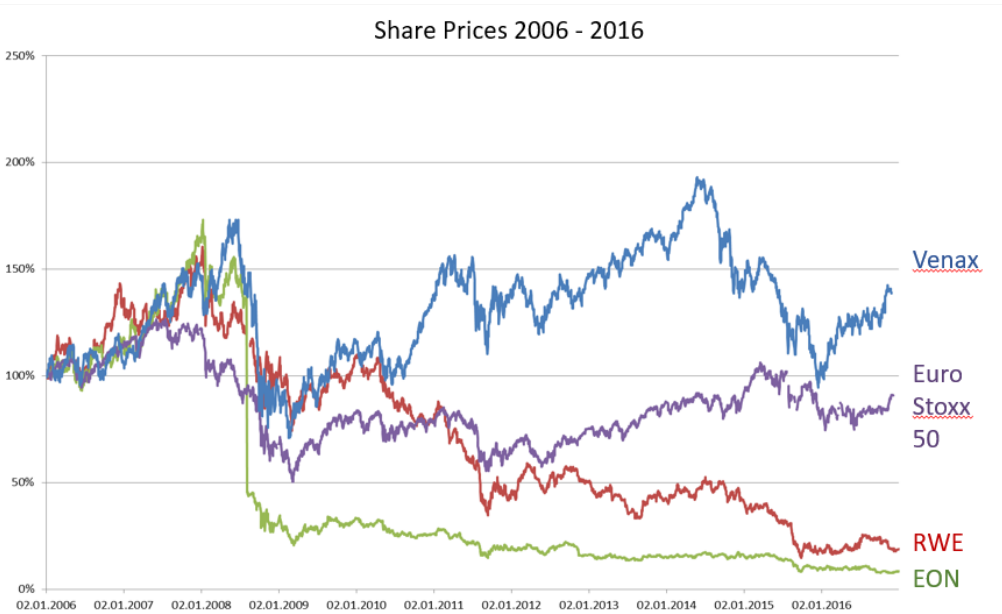


Figure 13: Energy company valuations[27]

[25] BMWi, Energiedaten, Tables 1, 4, and 10.
[26] It also includes the nuclear power plants. Political pressure insisted on keeping the liabilities from nuclear power within the E.ON{ XE "E.ON" } company.
[27] Company data, yahoo.finance.com.

Some tentative interpretations

There is a common perception that 'Fukushima' drastically changed the German energy policy, or that it at least significantly accelerated the different elements of the '*Energiewende*. The shutdown of the older nuclear power plants as a reaction to the Fukushima accident of 2011 certainly was a supply shock for the electricity system. The market, however, accommodated this shock quickly and efficiently. For most major elements of the '*Energiewende*', the year 2011 nevertheless does not stand out.

- Total primary energy consumption stayed almost constant after 2011, after a slight decrease in the years before Fukushima.
- The same holds true for emissions; in particular emissions from the electricity sector stayed almost constant.
- Energy efficiency slightly increased, but this process did not accelerate after 2011.
- Renewables kept on growing, at a slightly higher speed than before Fukushima.
- Nuclear decommissioning was accelerated, but usage of nuclear had already declined significantly before Fukushima. Indeed, the phase-out plan from 2011 is rather similar to an earlier plan from the year 2000.
- The large incumbent electricity companies suffered from the *Energiewende*, and Fukushima decreased the value of their nuclear assets; but these companies already lost significant value before 2011.

Rather, the decades from 2005 to 2015/16, with Fukushima in the middle, appear rather to have been an ongoing process of change, as opposed to a system that was shocked in the year 2011. Obviously, we do not know if all or some of these processes of change would have slowed down or stopped without Fukushima. The data just make it hard to argue that Fukushima constitutes a drastic change in German energy policy.

At the core of this change process, and for many the big success of the *Energiewende*, is the dramatic increase in the utilization of wind power and solar power in electricity generation and the decommissioning of nuclear power. We propose, tentatively, three possible reasons for this.

- First, environmental and climate policy issues featured prominently in the German public debate already for a long period.
- Second, there is widespread sympathy for 'technological' solutions instead of market economy solutions in Germany.
- Third, there was weak opposition by incumbent firms and strong public opposition against these major energy companies.

These arguments may at the same time help to explain the lack of support for more mechanism- (economics-) based approaches, i.e. carbon pricing, either as carbon taxes or cap-and-trade regimes. And the 'success' in terms of renewables and the decommissioning of nuclear power may overshadow the lack of progress on other fronts, in particular in reducing greenhouse gas emissions.[28]

As mentioned earlier, environmental issues had been important in the public debate since the 1970s, giving rise to a strong Green Party, which entered state government in 1985 (in Hessen) and the federal government in 1998. All other parties have reacted and included environmental politics in their

[28] Germany is part of the European emission trading system. In particular, the electricity industry is covered by this cap-and-trade system. National greenhouse gas reductions therefore have little (direct) climate effect. Nevertheless, national contributions remain an important policy topic, not at least within the Paris accord.

agendas. And already in the 1990s, the conservative administration of Chancellor Kohl had formulated a national greenhouse gas target to reduce emissions by 25 % by 2005, compared to 1990.[29]

The key mechanism that drove the expansion of renewable electricity sources is the subsidy scheme introduced by the renewable support act (EEG) in 2000. Despite the strong support from the left-green government (Social Democrats and Green Party), the act itself had a much broader backing and originated from an initiative by members of parliament from all major political parties.[30] Targets or quotas for renewable energies became a rarely disputed instrument for 'greening the economy' and often appeared to become ends in themselves.

Part of the scheme's success in Germany was the financing mechanism. Subsidies were financed by a levy on electricity consumption, mainly for households. The levy is now (2017) substantial (almost 7 €-Cents per kWh, comparing to a wholesale price of 3 to 4 €-Cents/kWh), amounting to payments with an average of almost 300 € per year for the average household. However, the levy increased only gradually, from 2.1 €-Cent/kWh in 2010 to 6.7 €-Cent/kWh in 2017, i.e., on average by less than 0.7 €-Cent/kWh per year. The levy is distributed across all consumers (exemptions being made for energy-intensive industries). Important beneficiaries are the wind and PV industries, investors in wind turbines, and households with PV rooftop installations. Although this means that the number of beneficiaries is substantial, it is still much smaller than the number of contributors – which, by the 'logic of collective action',[31] facilitates political implementation of this regime.

Given this broad support, it is not surprising that even after the conservative party took over, this agenda was kept widely unaltered. The then-new chancellor, Angela Merkel, played an important part when a renewable target was included in the European energy target system in 2007, and when the EU formulated the 20–20–20 agenda (which includes a target quote of 20 % renewables by the year 2020).[32]

Germany has a reputation for engineering. It is therefore probably not by chance that early efforts in wind generation research were realized in Germany, and they were realized as large-scale technology solutions.[33] There probably was always sympathy across all political parties for identifying 'green technologies' as promising for future industrial development, and worthy of political and financial support.

The combination of the perceived importance of environmental and climate policy aspects in the public debate, and the widespread sympathy for technological solutions and industrial policy may have served as important drivers for the *Energiewende*. Both aspects support a 'green industrial policy', which promises to combine the idea of technological progress (and growth and wealth) with the desire for sustainability. 'Greening the economy' is advocated not as a costly sacrifice to use less resources, but as a means of improving 'national competitiveness' in a global competition in promising fields of

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[29] Fischer, Severin, *Die Energiewende und Europa,* Springer VS, Wiesbaden 2017, p. 276. There were, however, few effective instruments installed to realize these targets. The largest contribution towards accomplishing this came from the shutdown of large parts of the industrial sector of the former GDR after 1990 which had caused large emissions but was non-competitive on the global market.

[30] Fischer, Energiewende**{** XE "*Energiewende*" **}**, p. 227.

[31] Olson, Mancur, Logic of collective action: Public goods and the theory of groups, Harvard University Press, 1965.

[32] Fischer, *Energiewende*, p 139.

[33] The 'Growian' project in Germany**{** XE "Germany" **}** was realized in the 1980s. It built the largest wind turbine at that time (3 MW capacity). The turbine itself faced considerable technical problems, and had to be shut down after a runtime of less than twenty days. Nicole Kronenberg, Schleswig-Holstein – Geburtsland der Windenergie. In: Dominik Collet, Manfred Jakubowski (ed.): Schauplätze der Umweltgeschichte in Schleswig-Holstein, p. 95-103.

industrial development and, in addition, to avoid imports from countries with governments that are considered, in Germany, as undemocratic. This logic promises growth, employment and fuel independence as an additional dividend of the *Energiewende*.

The *Energiewende* policy agenda clearly cut into the business model of the major incumbent energy companies and therefore triggered their opposition. That the incumbents were not successful in defending their position is due to many different factors. Johannes Teyssen, E.ON CEO since 2010, looking back in an interview in 2017, said: '*Yes, we knew it: the feeling of being invulnerable … Didn't we have close – perhaps too close – relations with politics?*[34]

One interesting detail may illustrate the misperceptions of their own strength, or even arrogance: All German energy incumbents, including E.ON, then the largest German energy company and seeking to expand further in Europe, were fully vertically integrated. They had fiercely opposed all attempts of the European Commission to unbundle the network from the generation business. And the federal government had strongly supported their case in Brussels.

However, in 2008, E.ON faced a cartel investigation by the European Commission. To accommodate the Commission, E.ON now agreed to sell off its network operations, and in return the Commission settled the cartel investigation. This happened without coordination with the German government: It so happened that E.ON announced its deal with the Commission on the very same day on which the German secretary of state had, once more and in line with the incumbents' official position, argued in Brussels against any separation of network and generation. This situation does not bode well for the building of future political support for the energy incumbents.[35]

Fukushima certainly did have an effect on German energy policy. Over a longer time horizon, however, the impression of major change fades away and is dwarfed by more fundamental changes in German energy policy. Two of these fundamental trends were slightly accelerated, namely, growth of renewable electricity sources and the decommissioning of nuclear power plants. The reasons for these developments are rooted much deeper in the German (energy) political landscape and require a comprehensive political economy analysis.

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