HEINRICH BÖLL FOUNDATION
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The German Coal Conundrum:

The status of coal power in Germany's energy transition

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1. Executive Summary

Germany has drawn international attention for its energy policies in past years. The term *Energiewende* – the country's transition away from nuclear power to renewables with lower energy consumption – is now commonly used in English.

The focus, however, has recently shifted to the role of coal in Germany. Over the last two years, media both in Germany and abroad have spoken of a possible "glowing future" for coal power and a "coal comeback" in Germany (Schultz 2012, McCown 2013). From the decision to phase out nuclear power, observers conclude "that domestically produced lignite… is filling the gap" (Birnbaum 2013). Indeed, statements made by German politicians over the past decade also suggest that these coal plants were intentionally built to replace nuclear plants.

Here, we have the coal conundrum of the *Energiewende*: is Germany building new coal plants to replace nuclear despite the country's green ambitions? This paper finds that the concern is based largely on a temporary uptick in coal power in 2012/13 (due to a cold winter and greater power exports) and on a round of new coal plants currently going online.

An in-depth look reveals that coal is not making a comeback in Germany. The current addition of new coal projects in Germany is a one-off phenomenon. Recent projects started in 2005-2007 as part of an overall trend in Europe caused by low carbon prices and upcoming stricter pollution standards for coal plants. New coal plants in Germany are unrelated to the nuclear phaseout of 2011 after the Fukushima accident.

Instead, renewables have more than offset the nuclear plants shut down. During the nuclear phaseout (until the end of 2022), this trend can be expected to continue, though the specific outcome depends on the actual growth of renewables and demand for power in Germany and neighboring countries.

The crunch is on hard coal. Conventional power plants serve a shrinking "residual load" – a crucial term in understanding the German power sector, as explained below – after the power demand covered by renewables. Less power will thus come from coal plants regardless of how many are built. Newly added capacity faces fewer operating hours. Given the surplus in power generation capacity, utilities are stopping new coal projects whenever they can.

Nonetheless, lignite is in a safe position during the nuclear phaseout unless policies are changed. Renewables have only slightly cut into demand for electricity from fossil fuel. Mainly, power from natural gas has been offset, with hard coal going next based on fuel price in the merit order. Germany lacks specific policies to reduce lignite and increase natural gas use. Unless that changes, the market is unlikely to bring about a reduction in power production from lignite until the mid-2020s.

Germany can reduce its coal dependency sooner: Policymakers can - and should - implement policies to reduce Germany's coal dependency before the mid-2020s: first and foremost by initiating a reform of the emissions trading system (EU-ETS). German policymakers should also consider taxing carbon and implementing a Climate Protection Act, focus more on efficiency, and strengthen natural gas as a bridge fuel. The EU is unlikely to find a consensus for ambitious policies anytime soon, so Germany should join forces with the large number of Member States willing to forge ahead.

A coal phaseout could focus on removing the most polluting lignite plants in Germany. The United States has stricter emissions standards; if similar requirements were applied, Germany could begin switching off its biggest emitters of carbon as well.

Finally, Germany's *Energiewende* proponents are not eager to correct the alleged but incorrect coal renaissance. Although talks of a "coal comeback" are overstated, Germans are not rushing to correct such misreports. This perception helps to keep pressure on policymakers to clamp down on coal consumption.

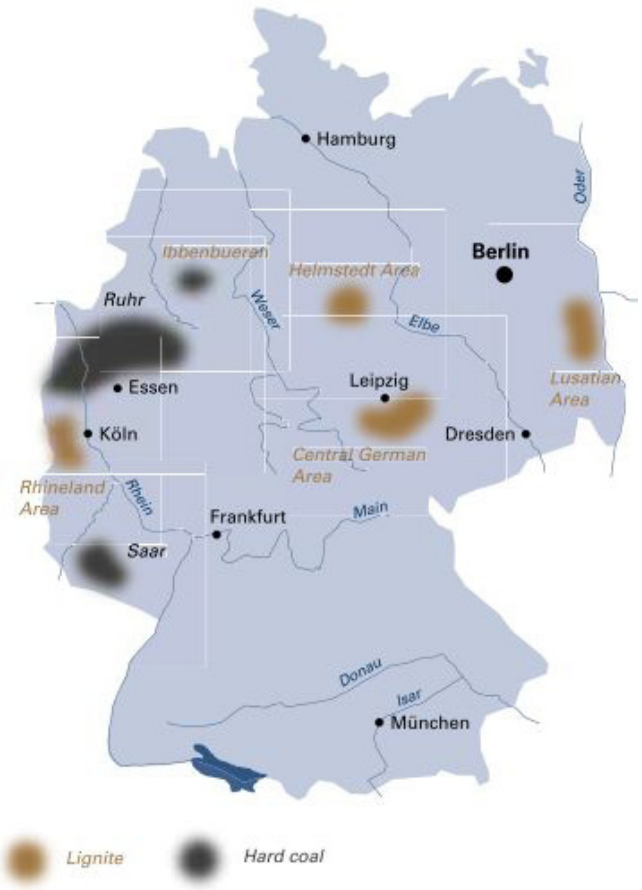


Figure 1: Map of German coal sites

Coal has historically been a major part of the German economy. The discovery of large coal deposits in the Ruhr region attracted industrial firms, turning it into the largest urban area in Germany with more than 5 million people. The region is largely known for its hard coal. Germany is, however, increasingly known for its production of lignite. Image: Euracoal.

2. Overview of coal use in Germany

Germany is still a major coal producer. In 2012, the country was seventh in hard coal mining and first in lignite mining globally (see Table 1). However, in terms of global coal demand, Germany makes up a relatively small share of the 2012 market at 3 percent, far behind China (48 percent), the United States (11 percent), and India (10 percent) (IEA 2013).

Germany has an estimated 2.5 billion tons of hard coal reserves, only 37 million of which will be mined until subsidies for coal mining are phased out in 2018. By then, German power companies will have switched completely from domestic to imported hard coal. This trend becomes visible when comparing domestic and imported hard coal over the last 20 year.

Like neighboring Belgium, the Netherlands, and Denmark, Germany sources its hard coal imports from Russia, Columbia, the United States, Australia and South Africa. In contrast to its relatively small, expensive hard coal reserves, Germany has 40 billion tons of cheap lignite reserves. At current mining rates, these reserves would last for over 200 years (Euracoal 2013).

Lignite comes almost entirely from domestic mining in Germany. Because of its low energy density and typically high moisture content, it is inefficient to transport and is therefore hardly traded on international markets. Given the limited resources of oil and natural gas, lignite is Germany's only domestic energy resource that will be economically viable for the foreseeable future in considerable amounts (Euracoal 2013).

Table 1: The ten biggest coal producing countries, (in million tonnes). *Source: Euracoal*

	Total Coal	Lignite
China	3549	-
USA	935	72
India	595	43
Indonesia	443	-
Australia	421	-
Russia	359	78
South Africa	259	-
Germany	197	185
Poland	144	64
Kazakhstan	126	-

Since 1990, overall German coal consumption has decreased by a third (see Figure 2). A significant share of this reduction goes back to modernization efforts in former East Germany in the early 1990s, efficiency gains in industry, and a switch away from coal briquettes for domestic space heating. This effect was, however, largely over by 1994. Since then, overall coal consumption has decreased by more than ten percent. The most recent uptick in coal use after the economic crisis in 2008 is still far below historic highs of the early 1990s.

The two types of coal together made up around 25 percent of German primary energy consumption in 2013. The country's biggest source of energy, however, remains oil at 33% of primary energy; oil is the primary energy source in the transport sector and the second largest in

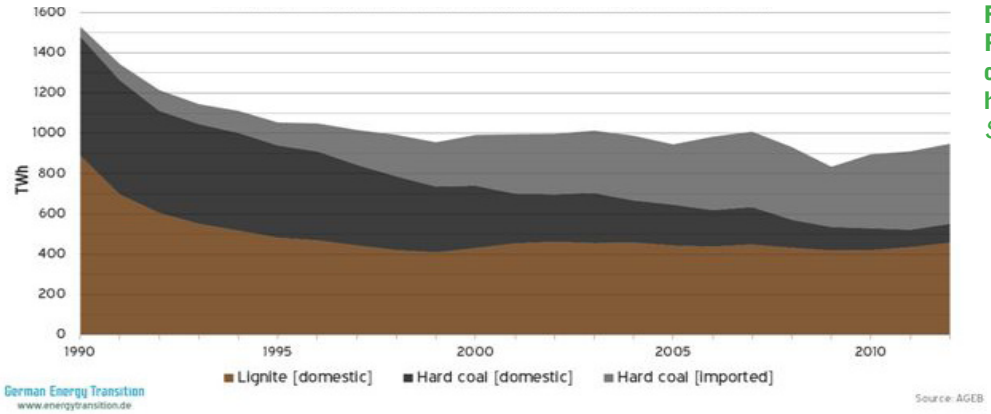


Figure 2:
Primary energy cosumption of lignite and hard coal in Germany
Source: AGEB

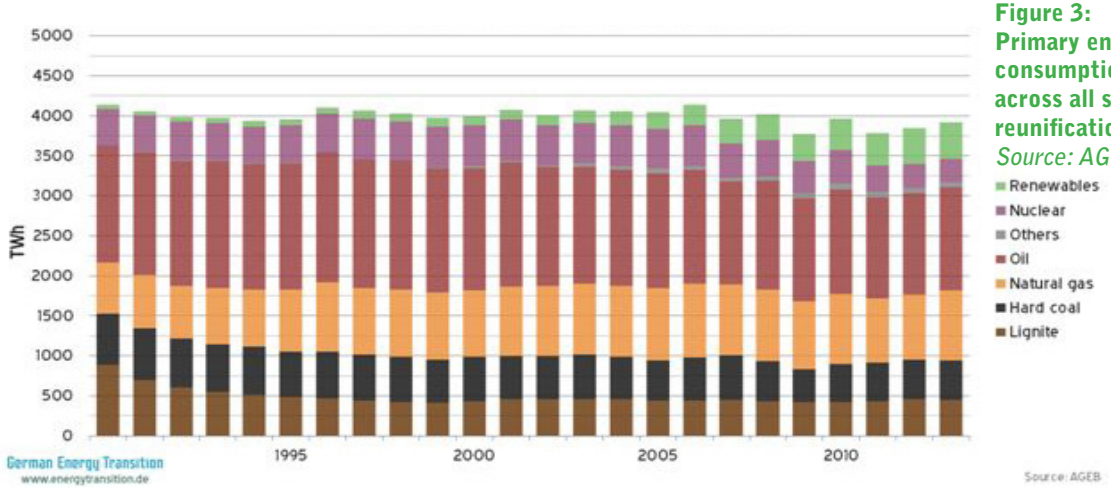


Figure 3:
Primary energy consumption in Germany across all sectors since reunification.
Source: AGEB

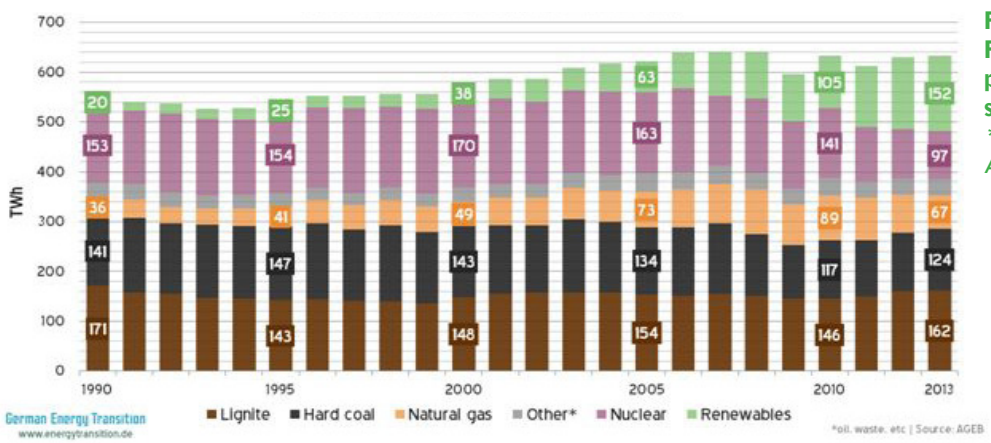


Figure 4:
Fuels for electricity production in Germany since reunification
**oil, waste, etc. | Source: AGEB*

the heat sector (after natural gas). Roughly, the power sector makes up one fifth of overall German energy demand, with heat and transport each making up two fifths. The share of renewables in total energy supply rose during this timeframe from 4 to 12 percent (see Figure 3).

a) Final energy: coal in the power sector

Germany is Europe's largest power market. After a few years of declining demand in the early 1990s, electricity generation has steadily increased. The economic crisis of 2008 led to a sharp drop in consumption. Since then, total power generation has not come back to pre-crisis levels, despite a boom of the German economy and increasing power exports – possibly an indicator of efficiency gains in the economy (see Figure 4).

During the 1990s, nuclear power was a solid pillar of power generation in Germany, providing up to 29 percent of electricity. Its share dropped only slightly after the initial nuclear phaseout (2002) but fell considerably after the post-Fukushima phaseout (2011) to 15 percent today. Over the next eight years, nuclear power is expected to be phased out completely.

Over the last 20 years, natural gas has never been as significant as coal or nuclear for electricity generation in Germany. After an increase in the early 2000s, gas has been losing ground again because of its comparably high fuel costs. Germany's energy-only market and the merit order (see box) mean that power plants with lower fuel costs (such as nuclear, lignite and hard coal) run more often. Overall, the role of gas was never explicitly addressed within the governing political mainstream. The issue of

Renewables have more than offset nuclear during phaseout

Germany is not building new coal plants to replace the gap left by the nuclear phaseout – because that gap does not exist. Renewables have more than replaced nuclear:

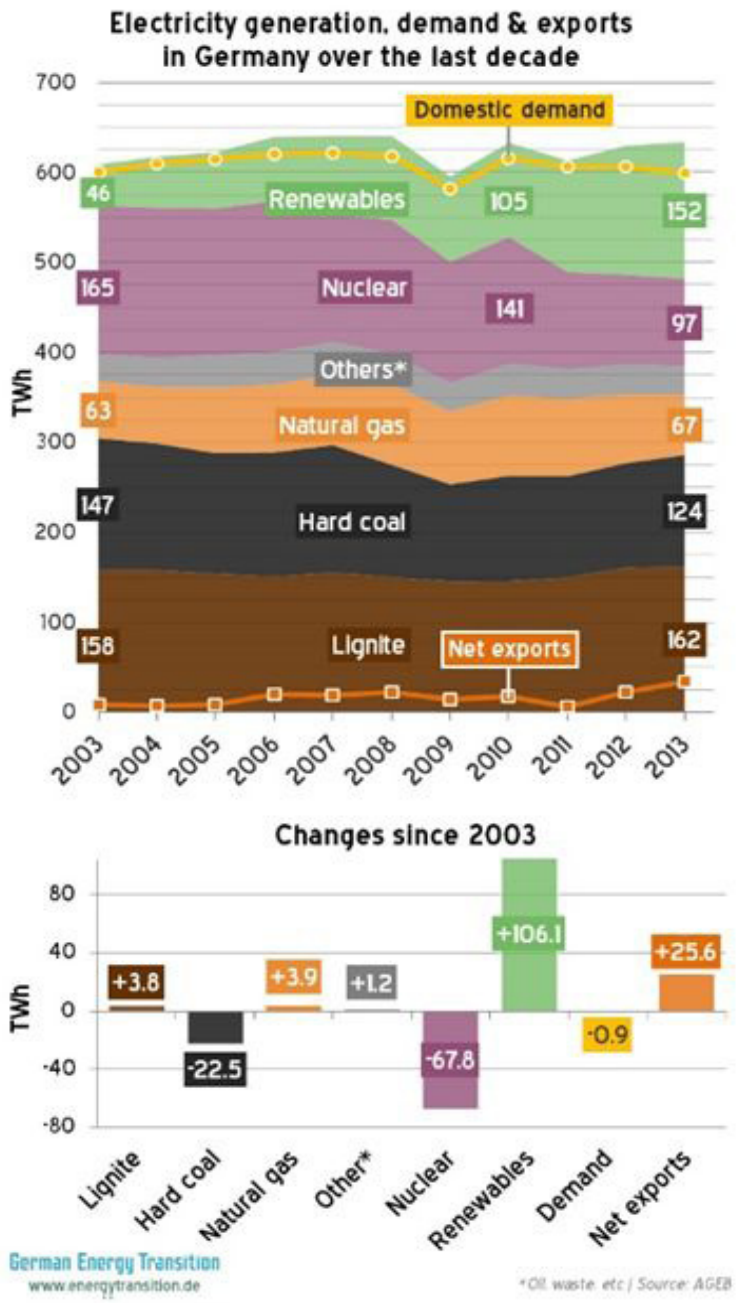
1. The first German nuclear plant (Stade) was closed in 2003 as a part of the initial phaseout that became law in 2002; the phaseout was revoked in 2010 but reinstated in 2011.

2. In 2003, Germany produced 165 TWh of electricity from its nuclear. The figure had dropped to 97 TWh by 2013, a decrease of 68 TWh. But over the same time, renewable electricity increased by 101 TWh.

3. Even since 2011, the year Germany shut down eight reactors, production of renewable electricity (46.9 TWh) has increased more than nuclear power has fallen (43.3 TWh).

Clearly, no coal power has been needed to replace nuclear, neither since 2003 nor since 2011. Nonetheless, power generation from lignite and hard coal has been up recently because of the rise in net power exports. German domestic power consumption actually fell from 2010-2013 by 15.5 TWh. In contrast, power generation rose slightly by 0.6 TWh. In other words, during those years net power exports nearly doubled from 17.7 to 33.8 TWh. Because of low wholesale power prices, Germany exported much more electricity to neighboring countries.

**oil, waste, etc. | Graph Source: AGEB*



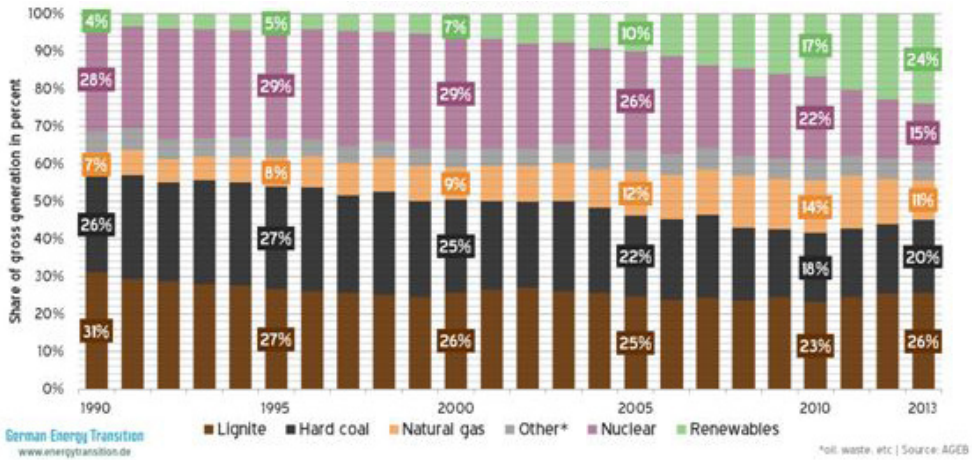


Figure 5: Shares of German gross power generation by energy source
**oil, waste, etc. | Source: AGEB*

choosing between gas and coal has been avoided and left "for the (carbon) market to decide" (Dickel 2014).

Renewables grew from three to six percent of power supply in the 1990s, mainly based on old hydro power and the growth of wind. Since the Renewable Energy Act of 2000, renewables have increased steadily, with onshore wind and solar as the main drivers. In 2013, renewables covered 24 percent of total power generation (including net exports), more than natural gas, nuclear, or hard coal; only lignite was larger. The government's target is to increase renewables to 40-45 percent by 2025 and 55-60 percent by 2035.

Coal (both hard coal and lignite) is a major pillar in Germany's power sector. Electricity generation from coal has remained fairly constant since 1990 in absolute terms. However, its share of power supply has fallen from 57 percent in 1990 to 46 percent in 2013 as power generation grew by roughly 10 percent (see Figure 5).

In 2013, there was an uptick in coal power in Germany largely related to power exports, with power from hard coal reaching a level not seen since 2008, while electricity from lignite reached a level not seen since 1990. Still, the share of coal power has not returned to its pre-crisis level of 2007.

Over the last 20 years, the efficiency of the coal plant sector in Germany has been increasing (Figure 6). From 1990 to 2013, power generation from coal went down by nine percent, whereas the amount of coal used to generate that electricity declined by 15 percent. Germany uses less coal to generate a unit of electricity today than it did in 1990. This greater efficiency leads to lower carbon emissions (see Figure 9).

With the recovery after the economic crisis in 2008 and increasing exports (see Figure 7), there has been an uptick in electricity generation from coal. This trend, however, was not limited to Germany. For 2012, the IEA identified a "temporary European coal fever" (IEA 2013). The OECD-Europe's increase of coal-generated electricity was mainly driven by the

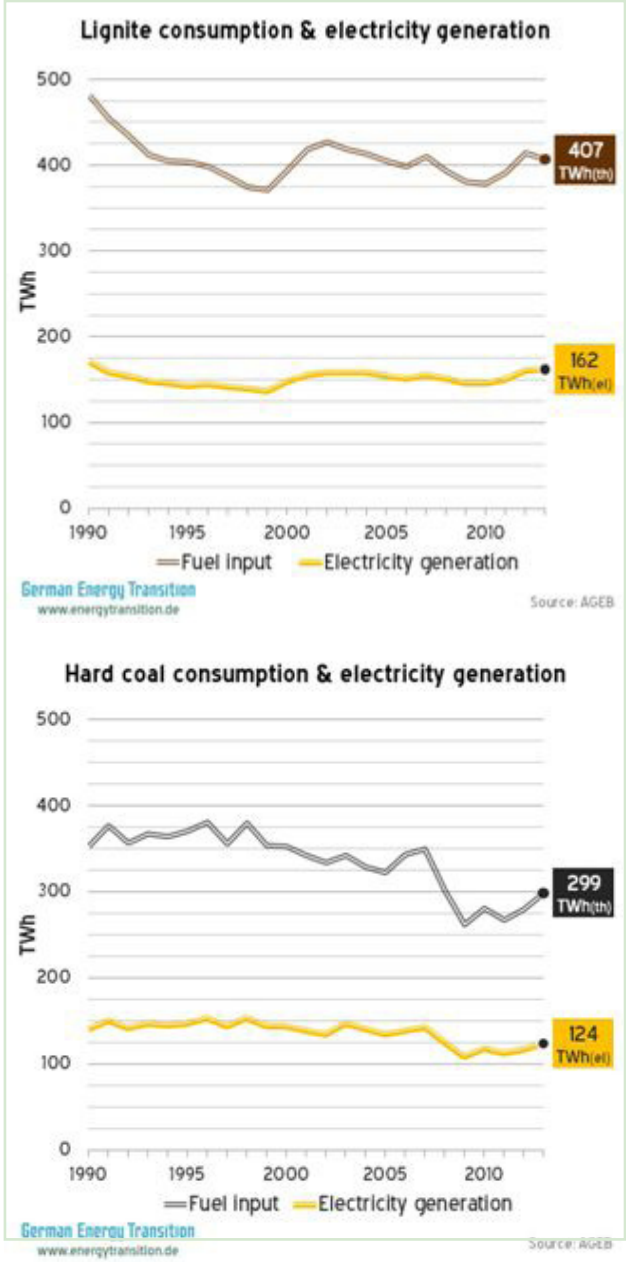


Figure 6: Consumption of coal and production of coal power. *| Source: AGEB*

The Merit Order

Germany has an energy-only market, meaning that payment is based on the number of kilowatt-hours generated. Most electricity is sold directly between producers and buyers in power purchase agreements, but these contracts are based on expectations of wholesale prices on the power exchange, where the rest of the electricity generated is sold.

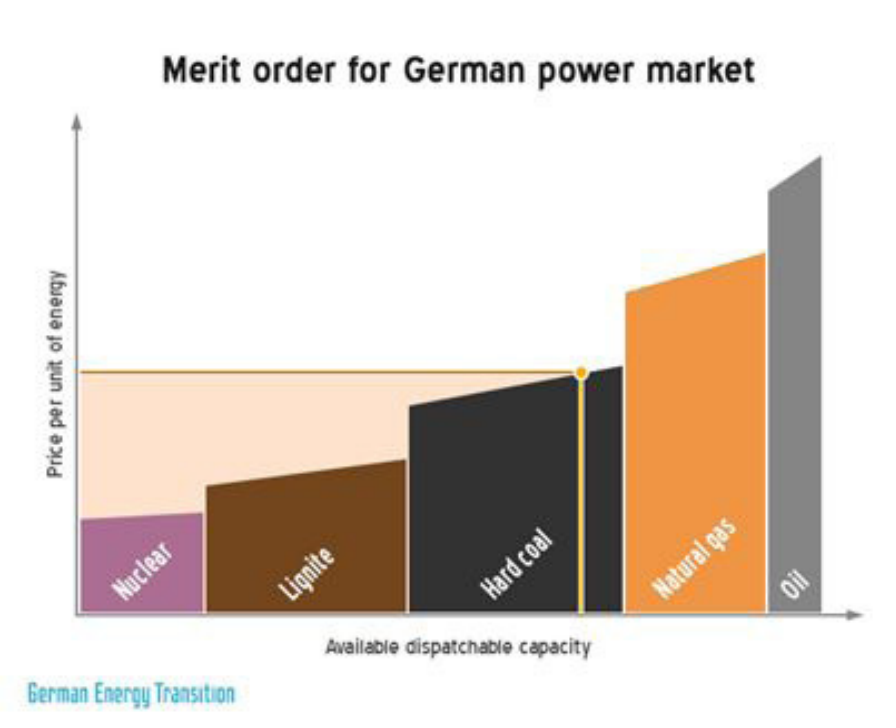
The price on the market depends upon the most expensive power plant required. Power plants are lined up in order of their fuel price. As demand for power increases (from left to right in the chart), power becomes more expensive, as indicated by the rising bars.

The chart to the right shows that nuclear plants have the lowest fuel prices, followed by lignite, etc. This depiction is, however, a simplification. In reality, there is overlapping. Gas turbines may, for instance, run quite often at a low level so they can ramp up quickly when required.

Renewables have the effect of lower consumption here. If renewable power generation increases, the demand for conventional power decreases because renewables have priority access to the grid.

Renewable electricity thus offsets conventional power from the right to the left, starting with power from oil (rare in Germany). Natural gas turbines to serve peak demand are offset next – and frequently these days. Hard coal represents the medium load and is increasingly offset when renewable electricity production peaks. The result is lower wholesale prices.

Nuclear will disappear by 2023, shifting all of the bars to the left. Lignite will then be the source of power the least affected by renewables unless policies change. The market is unlikely to switch the price order of lignite, hard coal, and natural gas in Germany without political guidance.



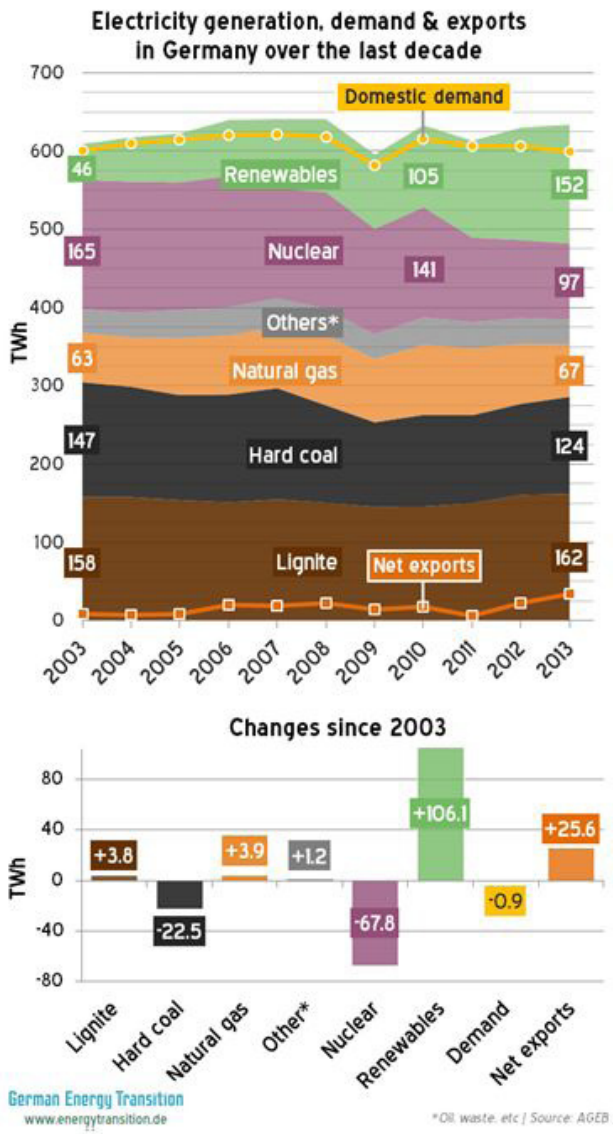


Figure 7: Trends in electricity sources over past decade; first nuclear plant was phased out in 2003
**oil, waste, etc. | Source: AGEB*

United Kingdom (plus 34 TWh), Germany (plus 15 TWh), and Spain (plus 11 TWh) (IEA 2013).

The recent uptick in German coal power production may now be coming to an end, however. In the first quarter of 2014, for instance, coal power reached a post-Fukushima low, with power from hard coal dropping by 17 percent year over year (Burger 2014). Hard coal plants are running fewer hours per year. The capacity utilization of hard coal plants dropped to 58.6 percent in Q1 2014 after 71.3 percent in 2013 and 63 percent in 2011 and 2012 (Argus 2014).

Given the continued growth of renewables, this year-to-year downturn of electricity from coal was expected in early 2014 (Morris 2014a). Indeed, the uptick in coal power in 2013 was also the result of the unusually cold winter of 2012/2013, which led to greater power demand overall in Germany and neighboring countries.

b) Net exports, "residual load", and emissions

Soon after Europe's power markets were liberalized in the early 2000s, Germany became a net exporter of electricity. Ironically, this started in 2003 (see Figure 8), the year in which the first nuclear plant was shut down as a part of the initial phaseout. The downturn in net exports in 2011 (after Fukushima) is clear to see. Still, Germany remained a net exporter even that year. In 2012, Germany posted a new record level, followed by yet another in 2013 – when power exports made up roughly 5 percent of total generation.

The increase in demand for German power from neighboring countries – primarily the Netherlands and France – is based on price; over the past four years, wholesale prices in Germany have fallen by 32 percent, largely because of the growth in wind and solar power (Morison 2014). Wind and solar power reduced Germany's spot market prices considerably: by 6 /MWh in 2010 and by 10 /MWh in 2012 (Cludius 2014).

The share of renewables in power supply grew by just over one percent in 2013, whereas demand dropped by a full one percent. The result was a domestic market for conventional power plants more than two percent smaller than in the previous year.

As conventional plants run for fewer and fewer hours, they begin to offer electricity at lower prices to encourage greater demand. These

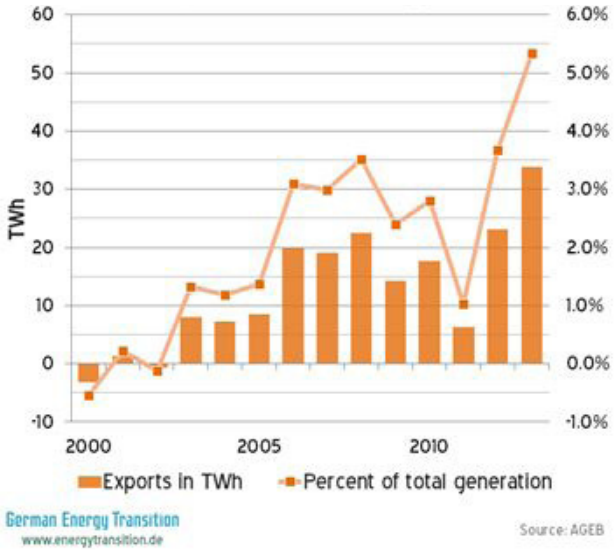


Figure 8: Trend in German power trade balance
Net electricty exchange and share of total generation in Germany / *Source: AGEB*

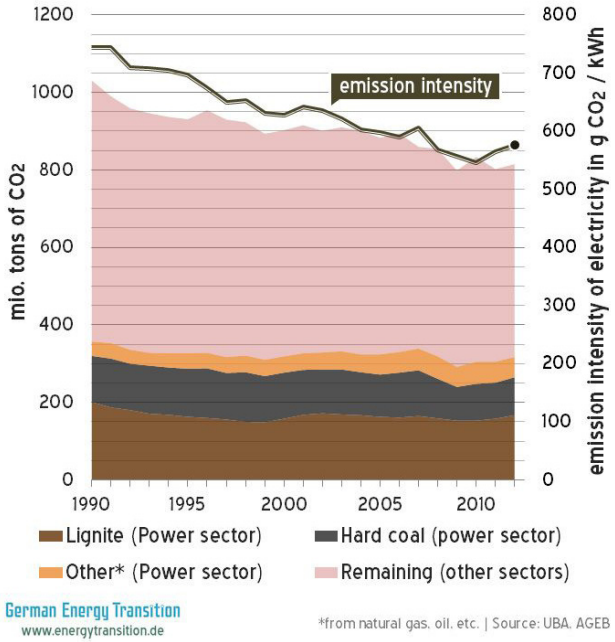


Figure 9: Carbon emissions from power sector relative to total emissions from all energy consumption
**from natural cas, oil, etc. | Source: UAB, AGEB*

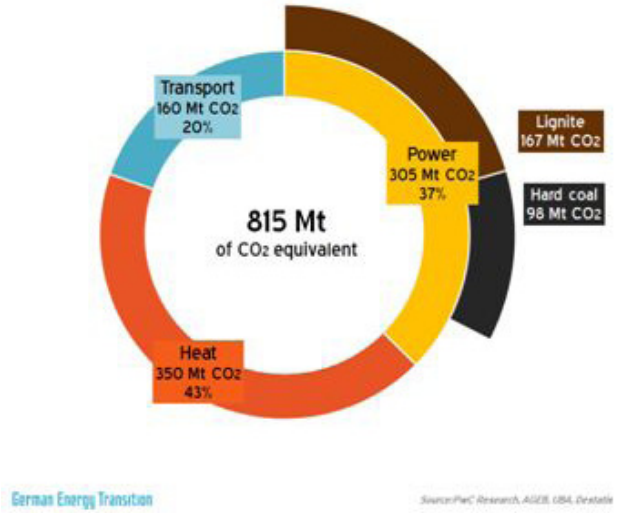


Figure 10: Energy related carbon emissions in Germany by sector 2012 *| Source: PwC Research, AGEB, UBA, Destatis*

lower wholesale prices entice buyers abroad, thereby increasing Germany's net exports.

These exports do not impact the generation of renewable electricity at all; rather, foreign demand directly increases conventional power generation in Germany. Renewable power has a priority on the grid and is therefore generated irrespective of demand. Hence, when German utility organization BDEW (German Association Energy and Water Industries) reported the preliminary figures for "power generation" (including exports) for 2013, renewables made up 23.4 percent of the pie – but that figure increased to 25 percent when expressed in terms of domestic demand (excluding exports) (BDEW 2014).

The BDEW points out, however, that it is not possible to say exactly how much each type of conventional electricity – nuclear, coal, and gas – was affected. But hard coal and lignite collectively make up around 60 percent of conventional power production in Germany, so in a rough estimate 60 percent of the five percent of power generation for export is three percent. In other words, around three percent of German electricity generation from coal was solely for export in 2013. This increase in coal power production attributes to Germany's carbon emissions though it serves foreign power demand – a form of "reverse carbon leakage."

From reunification to 2012, the carbon content of the German power mix dropped from 744g CO2/kWh to 576g CO2/kWh (Figure 9) (UBA 2013). During the economic crisis, overall emissions from coal went down to a historic low. Since the crisis, emissions from coal have slightly risen again. These figures include coal power for export. However, if we adjust for this export effect, carbon emissions might be 9 million tons lower in 2013, for instance.

Furthermore, most carbon emissions from energy consumption in Germany are not related to coal; here, coal makes up around a third of total emissions from energy. Energy needs for transport and heating are substantially higher than for power generation. Oil is a bigger culprit, so any policy focusing on reducing carbon emissions should have a scope extending beyond coal power (see Figure 10).

3. Reasoning behind new coal plants

The opening of numerous new coal plants in the past few years has led international onlookers to assume a connection between these reports and the nuclear phaseout after Fukushima. Given planning and construction times, such a connection is implausible, however. Coal plants generally have a project timeframe of 6-7 years in Europe (Bode 2005), so installations going into operation in 2013 were planned starting around 2006. Also, renewables have more than filled the gap left behind by decommissioned nuclear plants so far. Given the current financial difficulties that large utilities face – both in terms of falling profits and stock prices – the question is therefore what assumptions German utilities based their decisions on when they decided to start investing in new coal plants around 2006.

The German power market was liberalized in the late 1990s. Power providers that had done

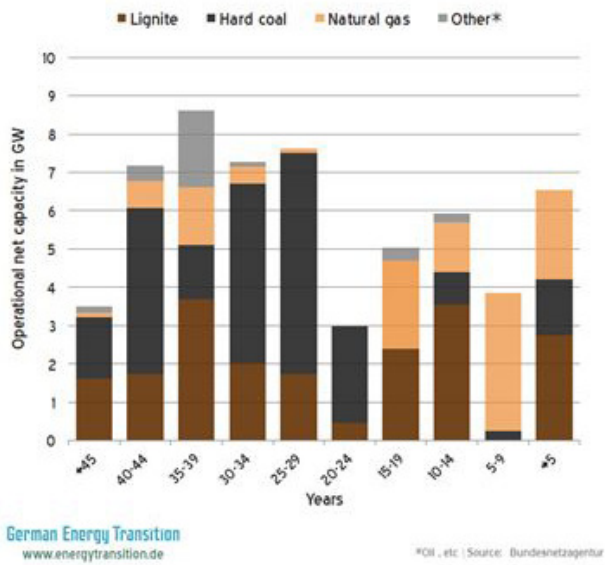


Figure 11: Age of current German power plant fleet. From 2000-2005, most new power plant projects concerned gas turbines. **oil, etc. | Source: Bundesnetzagentur*

business as regulated monopolies suddenly faced a new situation of competing with each other in electricity generation and sales. In the early 2000s, firms took a wait-and-see approach in the new business environment. The result was a delay in investments to replace old with new power plants (see Figure 11).

The chart shows a reduction in power plant projects shortly after reunification (the bar with plants 20-24 years old), with the next dip occurring in the first half of the 2000s (the bar wit plants 5-9 years old). Keep in mind that these ages indicate when the plants went online; planning and construction take several years. There is not only a downturn, however, but also a clear focus on natural gas. For these few years, at least, utilities were building the flexible capacity that renewables need; further incentives later came specifically for coal plants, as we will see below.

From 2006 on, power firms across Europe increased their capital expenditures considerably (see Figure 12). The wait-and-see era had come to an end during the first phase of emissions trading in Europe (2005-2008), which provided the companies with both investment certainty in terms of future climate targets as well as liquidity when emission allowances were handed out for free, but priced into electricity sales. Analysts estimate that German utility RWE alone received a windfall profit of roughly 5 billion euros in the first three years of the system (Kanter 2008). With the introduction of the EU-ETS, utilities had more cash to invest in new, capital-intensive power plants.

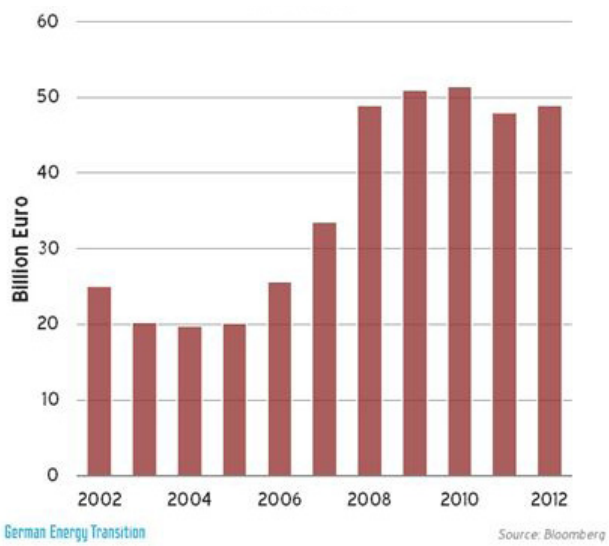


Figure 12: Investment volume at Europe's eight biggest utilities, 2002-2012 | *Source: Bloomberg*

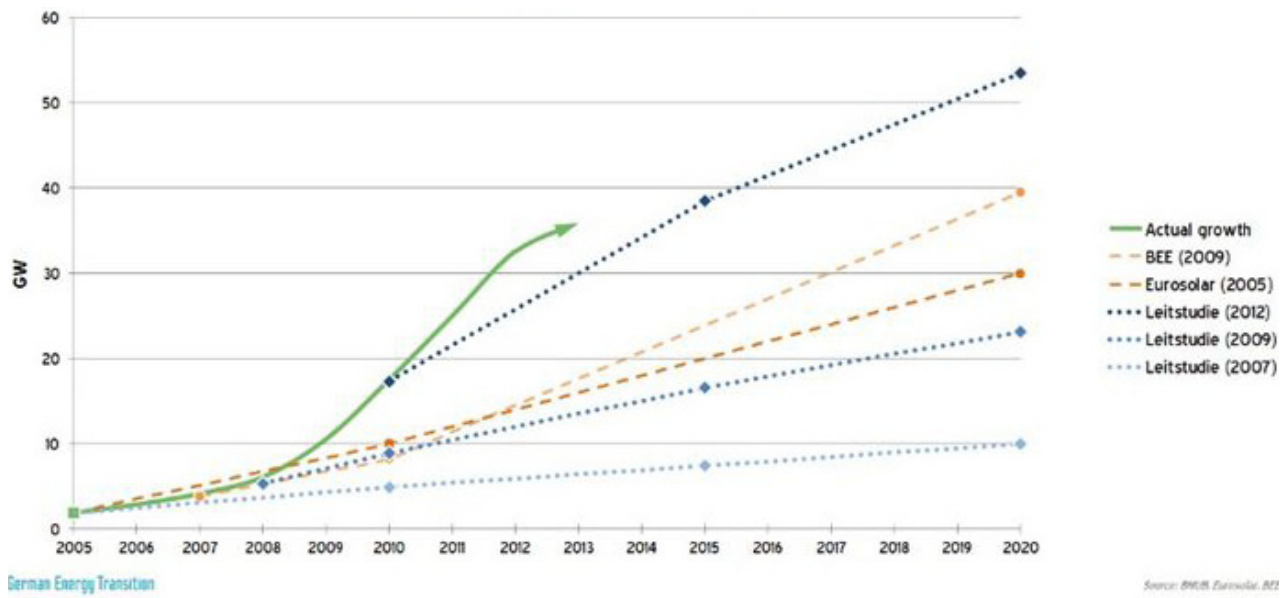


Figure13: Scenarios for the growth of photovoltaics in comparison with actual growth | *Source: BMUB, Eurosolar, BEE*

This trend stretched across Europe and was not limited to Germany. Specifically, this new wave of investments in coal plants predates the phaseout of eight German nuclear plants in 2011 by several years and is far too international to just be a reaction to the German nuclear phaseout of 2002. It only led to the phaseout of two smaller nuclear plants with a collective capacity of around one gigawatt.

In order to better understand why power companies chose to invest in new coal plants after 2005, we revisited the major reports and recommendations that such decision-makers were likely to have heeded (see Table 2). A majority of analyses back then suggested that new generating capacity was needed to replace old soon-to-be-decommissioned power plants, including nuclear reactors to be shut down. But few of the analysts saw the boom in solar coming even while it was clearly happening (see Figure 13). Moreover, there were sufficient indications that new power plants would result in surplus capacity. Utilities could only have seen a need for new conventional projects if they doubted the estimates for renewables.

Many studies between 2002 and 2008 (see Table 2) encouraged construction of new conventional capacity with a few warnings about the need for flexibility, which gas turbines best provide. Most of all, for renewables the estimates focused on wind power, with solar being largely overlooked.

The different impacts of wind and solar power on the residual load – the share of power demand not met by renewables – are therefore worth investigating. The Grid Study I of 2005 (dena 2005), for instance, references a scenario by German wind energy institute DEWI, which grossly overestimates the growth of offshore wind. Following this estimate, utilities should have assumed that the residual load to be covered by conventional power would be even smaller than it actually is. One logical reaction would have been to build fewer coal plants.

Likewise, in 2008 German utilities organization BDEW estimated the growth of renewables up to 2014 (BDEW 2008). By then Germany was expected to have nine gigawatts of photovoltaics installed, but in reality roughly 36 GW is already on the grid. But where BDEW fell short on solar, it overstated the growth of offshore wind. Like so many others at the time, its expectations of how the two technologies would develop were the reverse of the actual outcome.

Table 2: Overview of studies on German power sector from 2002-2008.

Year	Study	Estimate of new conventional plant capacity required	Notable aspects of study
2002	Enquete Commission "Sustainable Energy"	40-60 GW will need to be added by 2025 "unless power demand drops significantly."	Coal power production expected to increase up to 2020 but decrease afterwards until 2050. Backup capacity mentioned as requirement for wind power; solar not mentioned yet, and PV is tiny sliver in scenarios.
2004	DLR/IFEU/Wuppertal Institute	References Enquete's estimates, warns that new capacity will need to be flexible for wind power.	Compares overview of scenarios for wind power growth from five studies, without such a comparison for PV. In its own scenarios, the study includes solar power under "other."
2005	dena Grid Study I	New capacity needs to be built to replace upcoming decommissions.	PV subsumed under "Other." Growth of offshore wind greatly overestimated, and peak wind power production expected to peak at up to 40 GW by 2020, more than is likely.
2007	"Leitstudie" (Official Roadmap of the Energiewende)	38.3 GW of new capacity expected, 15.6 of which is hard coal and lignite.	Warning about shortfall in generation capacity, with total falling by 19.9 GW from 81.9 GW to 62.0 GW if only 17.3 GW is added.
2007	EWI/Prognos	Coal capacity to drop by 40 percent from 2005-2020 during transition to natural gas.	Average load factor of coal plants to drop as renewable power grows "mainly because of the less favorable residual load profile left behind after renewable electricity, which has priority on the grid."
2008	Consentec/EWI/IAEW	Great need for new power plant capacity expected for Germany.	Warning that Germany will be "a net power importer in the extended nuclear power scenario, though not until 2020 – and much less so than in the scenario with a nuclear phaseout."
2008	Federal Network Agency Monitoring Report	30.5 GW scheduled to be added by 2020, though only 20 GW is needed.	Firms should go ahead with all plans because "delays are always possible, especially in light of citizen protests against coal plants."

And like DEWI, the BDEW also thought that there would be even more renewable electricity on the grid than Germany actually has now. By 2014, onshore wind (nearly 11 percent) and offshore wind (nearly 8 percent) were expected to amount to a total of 19 percent of gross power production – 11 percentage points more than Germany actually has today.

While solar made up already roughly 5 percent of German power supply in 2013, the BDEW expected only 1.3 percent by 2014. Still, the organization expected wind and solar power to be at 20 percent this year, a full seven percentage points more than Germany had last year. With the utilities' own organization forecasting such strong growth of renewables, it is surprising that utilities still saw such a need for new conventional capacity.

Opinions of top politicians were similar at the time. To take one prominent example, in 2009, then-Environmental Minister Sigmar Gabriel stated, "We will need 8 to 12 new coal plants if we want to phase out nuclear" (Strom-Magazin 2009). Minister Gabriel made that statement pertaining specifically to a coal plant to be built near Mainz against strong citizen protests. The project was, however, abandoned in the end.

Gabriel's fellow Social Democrat Hermann Scheer, a staunch proponent of renewables, had been giving much different advice for years. In 2005, Scheer wrote that "no new fossil plants will be needed to replace old ones" (Scheer 2005). He also argued at the time that there would soon be "no need for baseload" (Scheer 2009). And by 2009, proponents of renewables were ringing the bell loudly.

The government's Advisory Council on the Environment argued in 2009 "When renewables make up a large share (of power supply), baseload power plants will be of limited use; instead, quickly dispatchable power plants and backup capacity will be needed." The head of the Council added that year, "that practically isn't possible with nuclear and coal baseload plants" (Odenwald 2009). In 2012, Volker Quaschning, Professor of Renewable Energy at the HTW Berlin, visualized this paradigm change from a baseload energy system to a flexible, renewables-based system with his "dental chart" (Figure 14).

German Renewable Energy Federation BEE concluded in 2009: "New conventional power plants will only be needed if additional power plants still in operation are retired ahead of schedule. Otherwise, there will be excess capacity, leading to power exports" (BEE 2009).

Today, however, there is widespread agreement that renewables will not only replace nuclear power, but also cut into baseload and further reduce the previously estimated demand for new capacity.

- Analysts at Prognos/EWI/GWS adjusted their expectations for new conventional power plants from 14.8 GW in the previous edition to 11.5 GW – as they put it, "despite the nuclear phaseout" readopted in March 2011 (Prognos 2011).

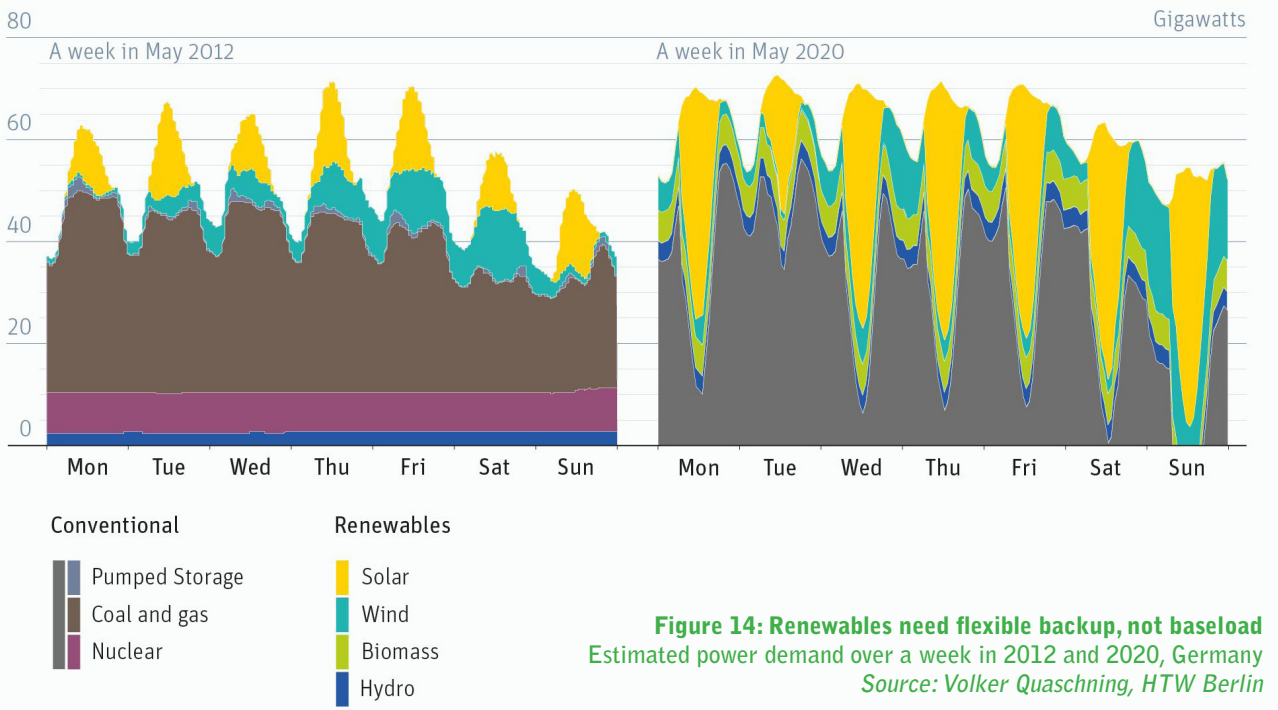


Figure 14: Renewables need flexible backup, not baseload
Estimated power demand over a week in 2012 and 2020, Germany
Source: Volker Quaschning, HTW Berlin

German Energy Transition energytransition.de

- In April, 2013, UK market researchers at Pöyry concluded for Germany: "No further coal or lignite plant investment in this decade" (Pöyry 2013).

- In October 2013, analysts at Citibank wrote that Germany's dependency on coal and the need to build new capacity had fallen. For Europe, the analysts expected a significant number of conventional power plants to be replaced or upgraded, "even if only to be mainly run as a back-up to renewables." Citibank estimates that only half of the decommissioned capacity would need to be replaced. "The rest of the closed capacity can be replaced by renewables and the increased availability of new plants vs. the ones they replace" (Citibank 2013).

As Chapter 4 shows, utilities are no longer interested in starting new coal projects. But as mentioned before, the influx of capital from emissions trading provided an encouragement to invest back around 2006. Given the expectations for the growth in wind power mentioned above, the firms could have decided to invest in wind power themselves – and continue to invest in natural gas turbines as complementary flexible capacity. Below, we investigate why they nonetheless chose to invest in coal – and why they almost entirely refrained from investments in renewables.

Each of these firms made decisions based on their own individual business case. In asking why German utilities invested in coal while the country moved towards renewables, we conflate business decisions with governmental policy. In many countries around the world, utilities are required, for instance, to have a certain share of their electricity from renewables as mandated by the government. German utilities are not. EU emissions trading incentivizes investments in new capacity.

As mentioned above, the EU emissions trading system (EU-ETS) provided utilities with an inflow of liquidity (EC 2014). Launched in 2005, the EU-ETS is the EU's center policy to reduce emissions from the power and industrial sector. Its initial ambition was modest. The real achievement was a cap on emissions and a price on carbon. EU Directive 2003/87/EC introduced the EU-ETS but left the task of allocating emission allowances in the two first trading periods largely to member states.

As a strategy of modernization of its power sector, the German government set up the allocation rules to trigger investments in new power plants. Two provisions in particular in the initial 2004 draft of Germany's National Allocation Plan (NAP) were crucial (BMU 2004a):

- Under the "new entrants rule", new power plants were granted free allowances on the basis of benchmarks derived from the best available technology. While existing power plants have to comply with emission reductions until 2020, new power plants receive free allowances on the basis of a fuel benchmark.

- The "transfer rule" allows allowances to be transferred from an old, decommissioned power plant to a new one. If a new plant replaces an old one, the firm can keep the allowance for the old installation for 4 years, and no reduction will be necessary for the new installation for another 14 years.

The reasoning for these policies was clear: the government aimed to provide firms with an incentive to replace old, inefficient facilities with new, more efficient ones. In 2004, Environment Minister Jürgen Trittin said the policies would incentivize new investments (BMU 2004b). Later, he announced that he expected 40 GW existing capacity in Germany to be modernized within the next 20 years (BMU 2005).

However, the European Commission dismissed the NAP draft because it interfered with the third trading period after 2012. The final NAP and the Allocation Act (ZuG 2012) adopted in August 2007 no longer contained 14-year free allowances for new builds; instead, it reduced allowances for new builds in line with the allocation rules for existing plants. Today, 100 percent of emission allowances need to be bought at auctions or from other market participants.

This policy change had a big impact on ongoing investments. Many projects under development were abandoned, but some had been fast-tracked and were thus too advanced for cancellation. In April 2013, consultants at Pöyry concluded that "the present tranche of coal and lignite plants must be understood as a legacy of very peculiar circumstances that are very unlikely to be repeated" (Pöyry 2013).

a) Little incentive to invest in renewables

Over the mid 2000s, German utilities could have invested in renewables, but they hardly did. In 2013, Germany's four biggest power firms – RWE, E.ON, Vattenfall and EnBW – owned

about 75 percent of power generating capacity from conventional sources, but less than seven percent of renewable capacity (excluding large hydro) (Trend:research 2013). Small municipal utilities, farmers, citizens, and energy cooperatives make up more than half of the investments in renewables today. There are two reasons why the big utilities did not invest more in renewables while so many other groups did:

- Moderate profit margins from feed-in tariffs: Utilities considered the expected return on investments in renewables too low. German feed-in tariffs were designed to provide investors with a modest 5 to 7 percent return (Couture 2009). Utilities, however, are used to higher profit margins in electricity generation and distribution. For instance, investments in the power grid have guaranteed returns ranging from 7.6 to 9.3 percent, and grid operators sued to have those rates increased to 11 percent (Spiegel 2012). Likewise, feed-in tariffs for offshore wind – built exclusively by large corporations – indicate the higher expectations for returns; feed-in tariffs for all other sources of renewable energy are fixed for 20 years, but a much higher rate is paid for offshore wind in the first eight years to ensure profits are generated quickly. In contrast, the prospect of a 5 to 7 percent return was enticing for citizen investors, for whom such returns normally entail much higher risks in conventional bank products.

- Expanding renewables undermines utility assets: Utilities understood that investments in renewables would hurt their traditional business model. Since renewables have priority on the grid, more electricity from renewables results in fewer operation hours of conventional power plants. In addition, the price for electricity generated by renewables is not paid on the wholesale market, but covered via a surcharge. Thus, renewables come in at zero marginal cost, lowering prices on the wholesale power market, with solar in particular reliably reducing peak prices at midday. The two factors put a squeeze on large utilities: conventional power plants sell less electricity at a lower unit price as renewable power grows.

b) *Utilities now regret investments in new coal plants*

Politicians and energy firms who believed in the 2000s that these coal plants would be needed were simply wrong; renewables have more than replaced the lost nuclear power production in terawatt-hours. The result is surplus generation capacity despite the phaseout of eight nuclear plants in 2011. Utilities are therefore backing away from new coal and gas projects whenever possible.

In April 2014, RWE's chief economist argued that new coal plants "make no return on capital" while new gas plants "failed to cover even O&M (operations and maintenance)" (Weale 2014). In his analysis, 40 percent of this outcome is the result of renewables growing faster than expected and 60 percent due to the financial crisis. Peter Terium, CEO of RWE, admitted a month earlier that the company was "late entering into the renewables market — possibly too late" (Andresen 2014).

The result is, ironically, the exact opposite of reports of a "coal comeback" in Germany; companies are stepping away from new coal plant projects wherever possible. Indeed, a growing number of German power sector organizations – such as the BDEW – are now concerned about the possibility of Germany not having sufficient capacity at the end of the nuclear phaseout in 2022. By April 2014, German power firms had asked the Network Agency for permission to shut down roughly 7.7 GW of conventional power plants ahead of schedule (BNetzA 2014).

Meanwhile, the German government has stated its intention to implement capacity payments to prevent too much capacity from being shut down. Essentially, dispatchable plants that are no longer profitable would receive compensation to keep them in business if the plants are considered necessary to prevent blackouts. Chapter 4 addresses what factors will influence the role of coal going forward – and why lignite, unlike hard coal, looks like being in a safe position until the end of the nuclear phaseout.

4. Lignite in safe position until 2020s?

The ongoing nuclear phaseout will reduce capacity until the end of 2022, although renewables can be expected to continue to more than compensate for that decrease. Nonetheless, the growth of renewable electricity will only slightly offset non-nuclear conventional power. In particular, electricity from lignite will be the last to go based on the merit order (see page 9). EU policy and German civil society, however, are calling for a transition from lignite to natural gas, as discussed below.

a) EU policy: stricter emission standards for coal plants

Efforts to reduce electricity consumption through efficiency across the EU will further tighten the squeeze on conventional capacity. But the deep political divide over the 2030 EU climate and energy policies and the potential relaxation of efficiency targets make it hard to quantify this factor going forward (Renssen 2014b). The recent declaration by seven eastern-central European countries in opposition to stricter carbon emissions is an indication of the challenges ahead (Renssen 2014a). But another EU law has already had a clear impact on the coal sector.

The EU's Large Combustion Plants Directive (LCPD 2001/80/EC) led to the perceived need for new baseload capacity among utilities across Europe (Butcher 2012). Adopted in October 2001, the LCPD specified that plants larger than 50 MW had to comply with stricter air pollution standards (such as SO2, NOx, and particles) or were to shut down by 2012. To comply with the LCPD, German utilities shut down twelve lignite and coal plants in 2012 with a total of 1.8 GW (BNetzA 2012). Furthermore, local authorities made some of these shutdowns a requirement in return for permits for new larger power stations.

In 2015, the LCPD will be replaced by the Industrial Emissions Directive (IED 2010/75/EU) (EC 2010). For the power sector, the IED has stricter emission limits (Pöyry 2013). The BDEW expects the regulation to lead to permanent shutdowns of old coal-fired power plants in Germany totaling around 6 GW between 2013 and 2017 (Kohlmann 2013). The standards as implemented in Germany's Federal Immission Control Ordinance are not as ambitious as those in the United States, however. According to a recent study, 49 out of 52 coal-fired power plants in Germany would fail to meet current US mercury standards (Zeschmar-Lahl 2014).

b) Civil society's call for a coal phaseout

No new coal plant is built in Germany without fierce public opposition. To take one example, the new Moorburg hard coal plant going up outside Hamburg was protested from the outset. In 2007, 12,000 citizens petitioned the government to review the plans. The result was stricter environmental regulations, which made the plant more expensive. Vattenfall reacted by suing the German government at the International Center for the Settlement of Investment Disputes for 1.4 billion euros. While the two parties eventually agreed to settle out of court, the signal sent to citizen protesters was nonetheless devastating – if citizen protesters block coal plants, the public may end up compensating power firms for the forgone profits the companies could otherwise have posted (Hoenig 2010).

Another dramatic example is Datteln IV, a hard coal plant left 90 percent completed when challenged by environmental groups, farmers and local citizens. A state court put a stop to construction in 2009. E.ON, the investor, hopes to go online with the plant by the end of 2016, more than five years late (Meier 2014).

Environmental organization BUND (Friends of the Earth Germany) is one of the main groups campaigning against coal power in Germany. In its overview of the coal plant projects from April 2013, it lists 21 projects that went online since 2005, with an additional five being "on the chopping block" (BUND 2013).

The protests against coal also cover lignite mining, not just power plants. In March 2014, the state government of North Rhine-Westphalia responded to public opposition to lignite mining when it announced that the Garzweiler coalfield would be smaller, with some 300 million tons of lignite left in the ground (Morris 2014d). At the end of April, however, the state of Brandenburg extended lignite excavations for an additional 200 million tons after 2027. In this case, a campaign funded by the utility Vattenfall collected 68,000 signatures from citizens and prevailed over the 121,000 signatures from opponents (Arzt 2014).

Furthermore, with increasing imports of hard coal, NGOs are expanding their work on mining and financing abroad. The NGO Urgewald is focusing on developing countries with lower environmental standards. The umbrella group Climate-Alliance Germany (Klima-Allianz) has launched a campaign against Germany's public banking group KfW, one of the few western development banks that has no policy to end coal investments (Climate-Alliance Germany 2014).

Popular resistance to carbon capture & storage (CCS) is also strong in Germany. The government does not see political acceptance within Germany to move the technology forward (Morris 2012). Vattenfall stopped its CCS demonstration plant in Jaenschwalde in Eastern Brandenburg in December 2011 (Lang 2011). The smaller CCS pilot installation near Berlin,

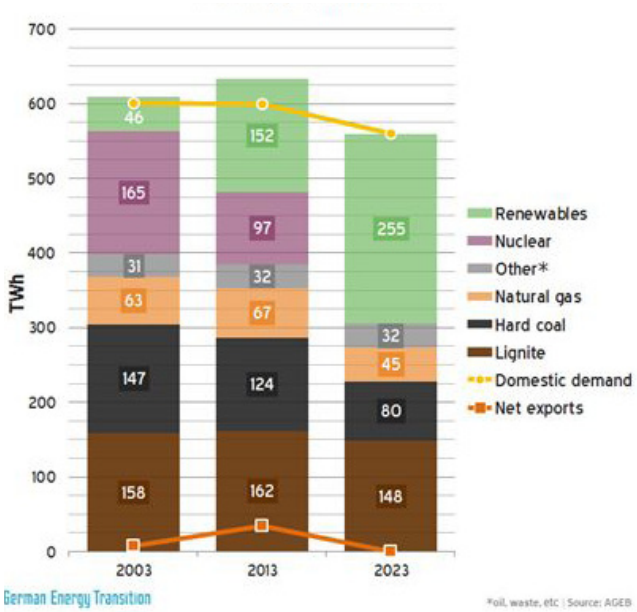


Figure 15: Power generation in Germany during nuclear phaseout (estimate for 2023)
**oil, waste, etc. | Source:AGEB*

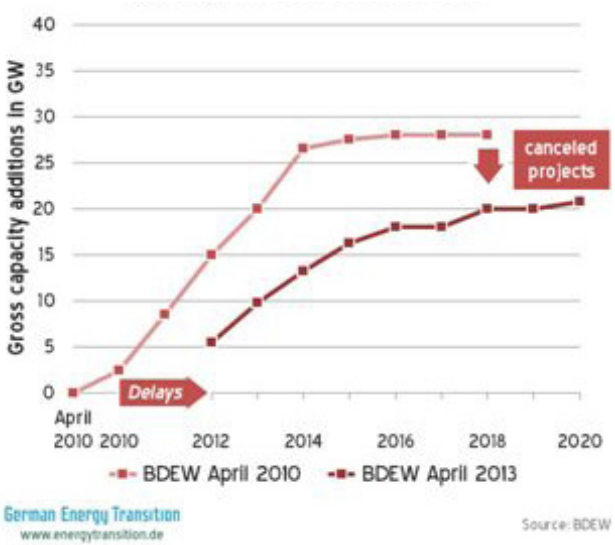


Figure 16: Reduction in plans for new conventional capacity *| Source: BDEW*

Schwarze Pumpe, is scheduled to shutdown in July 2014 (Seidler 2014). It joins the long list of international CCS projects being cancelled (Herzog 2014).

c) Capacity crunch: less MWh from more MW

With their investments, power firms have added megawatts of new coal capacity in recent years and built up a surplus in generation capacity; but while overall installed capacity has risen, domestic demand is slightly down. What's more, each year renewables generate more electricity - 25 percent of domestic demand in 2013 and counting. The government's target is to increase the share of renewables in power generation to 40-45 percent by 2025 and 55-60 percent by 2035 (Bundesregierung 2014). Thus, utilities need to generate increasingly fewer megawatt-hours to meet domestic demand. Demand from neighboring countries – power exports – are a relief for utilities since it directly increases production of conventional power.

Some jurisdictions around the world curtail renewables to protect conventional power plants. In Germany, however, green electricity has priority grid access and is only curtailed when power lines physically cannot absorb more electricity after conventional plants have ramped down. Overall, very little renewable electricity is curtailed in Germany: 0.4 percent in 2011 and 0.3 percent in 2012 (Morris 2014b). In other jurisdictions, wind power is curtailed more often (such as in the UK and Ontario) (Morris 2014c, IESO 2013).

The further growth of renewables will result in less space left for electricity generated by conventional power plants – a smaller residual load. Figure 15 shows an estimate how power production by source will change over the time of the nuclear phaseout, from 2003 (when the first nuclear reactor was shut down) to 2023 (the first year without nuclear power). For the sake of simplicity, the following assumptions are made for 2023:

- Renewables are expected to grow in line with the government's current targets of 40-45 percent renewable electricity by 2025. Solar is expected to stop at the official target of 52 GW for feed-in tariffs.*
- Power exports are assumed to be zero.*
- Power demand is expected to drop overall, as forecast in the most recent *Leitstudie*, the regularly updated roadmap for Germany's energy transition.
- Nuclear power will be completely phased out.

**The first assumption means the estimate for renewables is conservative, the second that the estimate for conventional power is conservative. In combination, the two assumptions roughly balance each other out.*

By 2023, renewables will have long been the largest pillar in power generation. Renewables will have completely offset the drop in nuclear power while only slightly cutting into fossil fuels. With its high fuel costs, natural gas remains at low levels. In comparison to today, hard coal could drop by a third. Given its low fuel costs, lignite will remain in a relatively stable, safe position.

As renewables grow, German utilities face a more and more painful situation. Unless domestic and international demand rise, utilities will sell less electricity from their conventional power plants. More conventional power plants will not lead to more power generation from these power plants. Here, many onlookers misunderstand the German situation when they claim that Germany is switching to coal because it is building a lot of coal plants. The assumption is that more MW will lead to more MWh. In reality, more MWh will come from renewables, with conventional generators left to cover shrinking residual demand. Conventional plants will operate fewer hours per year – resulting in a lower capacity factor.

This increasing capacity crunch is the reason why German power firms have scrapped plans for new plant construction in recent years (see Figure 16). It is the utilities themselves that are increasingly reluctant to invest in coal plants.

5. Conclusion

Within not even a decade, German utilities have moved from a perceived need to build new coal plants to a realization that these new builds are not going to be profitable. International reports about the alleged "German coal renaissance" thus not only coincide with the opening of around a dozen of new coal plants, but also with a long list of requests for early retirement – and roughly two dozen canceled coal plant projects. Contrary to reports that Germany began replacing nuclear with coal after the post-Fukushima nuclear phaseout, German utilities began abandoning coal projects around 2011.

The coal surge in Germany was part of a Europe-wide trend, not a reaction to Germany's nuclear phaseout, and it began as a result of the first phase of emissions trading in the mid-2000s. Future policy changes at the EU and domestic level could continue to remove more coal capacity than is added, and Germany will continue to fill the gap left behind by coal largely with renewables.

Without a strengthening of the EU-ETS or other policy changes, natural gas is unlikely to offset coal until the early 2020s. With growing renewables, however, hard coal will also be squeezed out of the market. Many hard coal plants will operate at low capacity levels. Lignite, the most damaging fuel for the climate, is likely to remain in a relatively safe position in Germany while nuclear plants are phased out (up to the end of 2022). Overall, a coal phaseout driven by renewables' growth will not begin until after the nuclear phaseout in 2023.

Nevertheless, German policymakers could implement policies to reduce coal consumption before 2023 and start an overall coal phaseout. More importantly, if Germany is to reduce its carbon emissions, it will have to look beyond the power sector. Overall, oil is the largest source of carbon emissions within the energy sector as a whole. The *Energiewende* has rightly been criticized for being an electricity transition, not a true energy transition. More attention should be devoted to the heat and transport sectors.

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