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Towards a Less Ambitious Energy Transition for Germany

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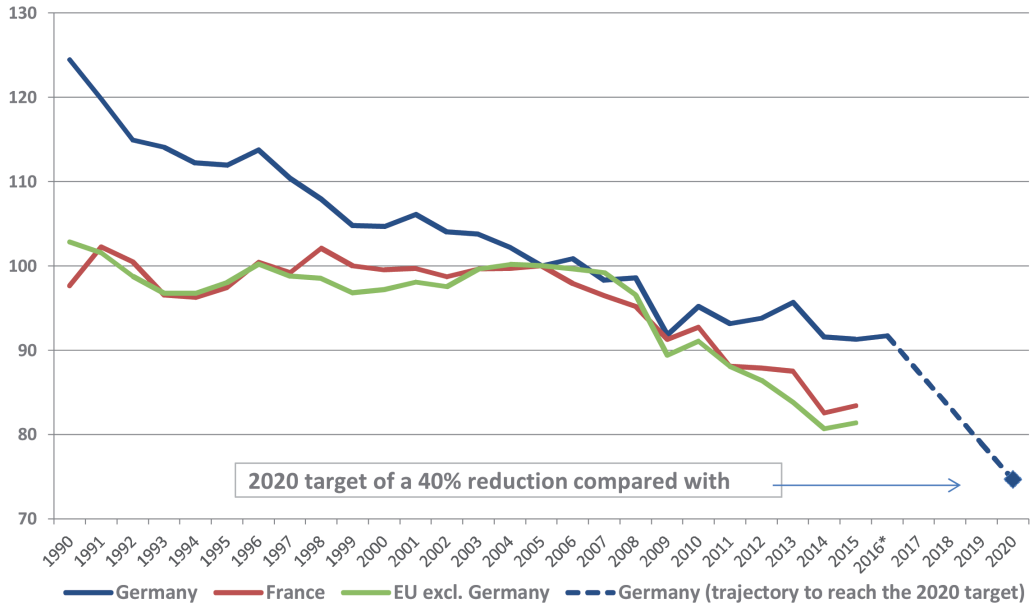
In the wake of the 2011 Fukushima nuclear disaster, the German authorities launched the country's energy transition, or *Energiewende*. With near unanimous support of Germany's citizens, it was seen as a society-wide project.

The enthusiasm the Energiewende generated soon spread beyond the Rhine. Indeed, for many French people it became the model to follow. Replacing nuclear energy and fossil fuels with renewable energy sources that were local when possible, developing electric mobility and making progress towards a zero-carbon economy were all virtuous goals. What's more, it seemed they could be attained over a relatively short period of time and at reasonable cost.

Today, the Energiewende's future looks less bright. While Germany produces a third of its electricity from renewable energy, this comes at a high price. The cost of electricity for small consumers more than doubled between 2000 and 2013. At the same time, the country continues to rely on coal to produce a large share of its electricity and still has one of the highest levels of CO2 per person in Europe. But Germany's population is divided about closing its coal-fired and lignite power plants, not to mention doing so would jeopardize its energy supply. Add to this the fact the massive development of intermittent renewable energy sources has made the German power grid unstable and has necessitated the construction of thousands of kilometres of high voltage lines admidst strong local opposition. Lastly, electrifying the transport sector could serve to compound the series of scandals that have hit the automotive industry.

Against this backdrop, the coalition government formed following the September 2017 federal elections could very well lower the bar for the Energiewende.

Comparative greenhouse gas emission development in Germany, France and the European Union (baseline of 100 in 2005)



Source: Eurostat and BMWi[1] for the 2016 data, calculations France Stratégie

1. BMWi, *Bundesministerium für Wirtschaft und Energie* (Federal Ministry for Economic Affairs and Energy).

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INTRODUCTION

With the Federal elections only a few weeks away, this policy brief provides an assessment of the German energy transition's progress (first part), but also the challenges encountered (second part) and areas of resistance or even barriers that it risks bringing about among the population (third part). Reviewing the programmes of the German political parties, it finally shows that we can expect a significant reorientation of energy policy after the elections (fourth part).

A SPECTACULAR TURNAROUND, STILL INSUFFICIENT

À The major aims of the German energy transition involve, in addition to abandoning nuclear in 2022, an almost complete zero-carbon economy by 2050 thanks to the widespread development of renewable energy sources and a reduction in consumption. Table 1 summarises their progress in 2000 and 2015 (2016 for some). Aside from electrical renewable energy which has experienced a spectacular growth and which should exceed 35% of the energy mix by 2020, it appears that no other targets are achievable. The McKinsey firm, which keeps a quarterly index of the fifteen main *Energiewende* targets, even notes that, conversely, for eleven of these targets, there was a drift away from the 2016 goal.

Renewable energy: 2020 target almost reached, uncertainty beyond

The replacement of conventional energy sources – nuclear, coal and gas – with renewable ones is emblematic of the German energy transition. Solar energy has been presented as an alternative to nuclear and oil since the 1970s, yet its development remained moderate until the start of the 2000s. The fight against climate change and the tensions over raw materials therefore led to the first laws in favour of renewables, with renewed ambitions after Fukushima. This grand plan was not without a hidden industrial agenda: Germany aimed to become the leading country in these renewable energy sources and to find renewed growth for its traditionally export-based economy. There would also be the prospect of creating an economic fabric in the Eastern Länder, recently reunified.

What followed is widely known. The significant grants allowed for spectacular development of renewable energy, mainly biomass, wind and photovoltaic (PV) solar, with a share in the electricity consumption which jumped from 6% in 2000 to 32% in 2016. Now, hydropower is seeing its development limited by the lack of sites and biomass by the competition with human consumption[2]. The growth of renewable energy therefore now relies on PV solar and on wind.

PV solar has experienced considerable growth from 2010 to 2012, followed by an abrupt standstill, the reduction in public grants prevailing over a 60% drop in the price of panels over five years (graph 1). The installed capacity at the end of 2016 reached 40 gigawatts (GW), but the production, 38.1 terawatt-hours (TWh), only represents 6.4% of the total electricity production. Not able to withstand the Asian competition, all the major manufacturers of German panels have gone bankrupt, the last being SolarWorld in June 2017. In all, approximately 100,000 jobs were lost in the sector between 2012 and 2016, severely affecting the Eastern Länder as well as Thuringia and Saxony[3].

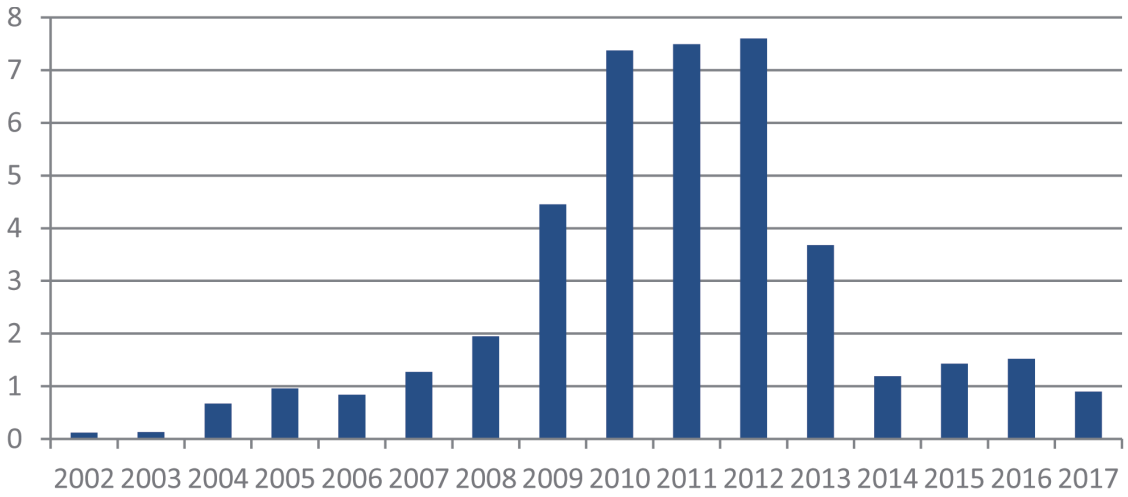
Table 1 – Target time-frame for the Energiewende

		Achieved			Targets		
	réf.	2000	2015	2016	2020	2030	2050
CO_2 emissions	1990	- 15.0%	- 27.2%	- 26.6%	- 40%	- 55%	- 80%
Share of renewables in energy consumption		6.5%	31.6%	31.7%	35%	50%	80%
Primary energy consumption	2008	+ 1.5%	- 7.6%	- 6.5%	- 20%		
Electricity consumption	2008	- 6.7%	- 4.0%	- 3.4%	- 10%		
Energy consumption of transport	2008	+ 7.0%	+ 1.3%		- 10%		
Electric vehicles		0M	0.03M		1M	6M	

Interpretation: In 2000, the German CO2 emissions reduced by 15% compared to their level in 1990. The target set by the authorities is a reduction of 40% by 2020 (compared to 1990).
Source: France Stratégie according to the McKinsey data, March 2017, and BMWi

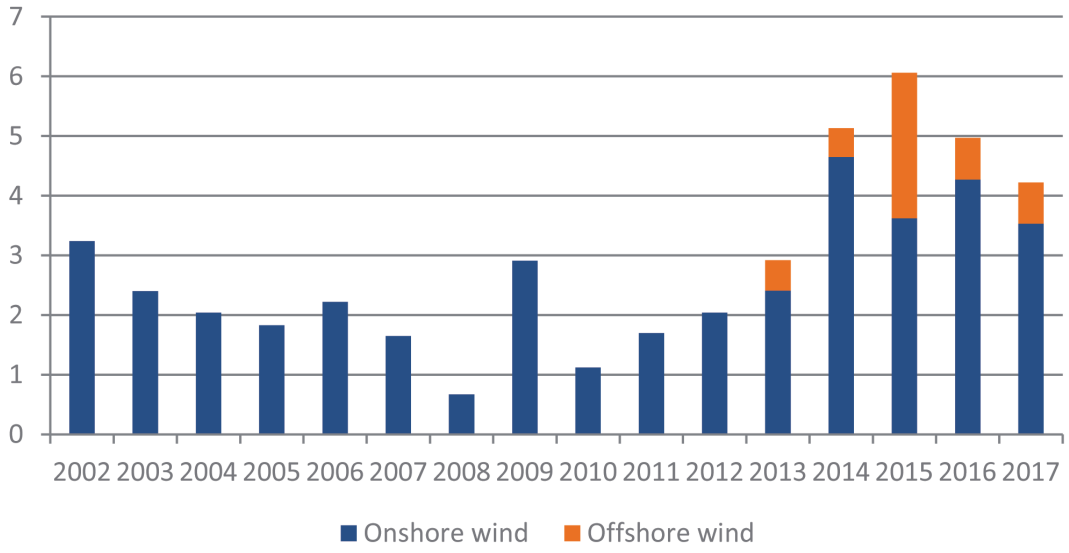
2. Biomass for electricity production in Germany relies mainly on biogas coming from dedicated crops, maize in particular. New crops have been banned since 2014. Biogas is also used for the production of heat, just like wood and organic waste.
3. See, for example, the *Dresdner Neueste Nachrichten* of 27th June 2017.

Graph 1 – Annual installed capacities in PV solar (in gigawatts)



Source: France Stratégie based on data from AGEE, BMWi and BNetzA[4]

Graph 2 – Annual installed capacities in onshore and offshore wind (in gigawatts)



Source: France Stratégie based on data from AGEE, BMWi and BNetzA

The development of wind was equally as spectacular, but more regular, to reach, by the end of 2016, an installed capacity onshore of 45.5GW and 4.1GW offshore, and respective production values of approximately 65 TWh and 13 Twh, or 13.2% of the electricity production (graph 2). The sector was worth 13 billion euros in 2016 and employed 135,000 people, mainly in the North Länder, Lower Saxony and Schleswig-Holstein. A "last minute rush" has seen the submitting of numerous projects before the deadline of 31st December 2016, after which the new law, adopted in the middle of 2014, provides for the abandoning of the feed-in tariff and a ceiling of 2.5GW per year, which is creating uncertainty.

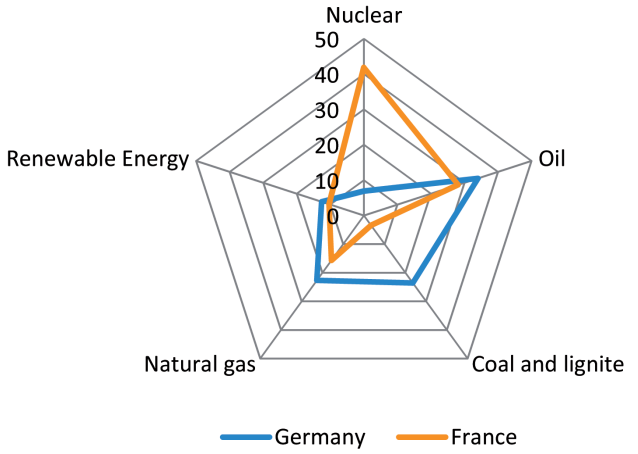
The future growth of renewable energy relies largely on that of offshore wind, with a target of 6.5GW by 2020. The share of renewables in the consumption of total primary latest calls for tender (April 2017) have revealed a reduction in costs to an extent which is difficult to explain[5]. Although these projects are materialising, we can expect strong development as the yields of offshore

4. BNetzA, Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen (Federal Grid Agency).
5. These are the OWP West, Borkum Riffgrund West 2 and He Dreiht plants, the DONG and EnBW energy providers which stated they were able to go without grants. The exact cost is not known, but it is likely a lot lower than €50/megawatt-hour (MWh), to which it is advisable to add the grid connection which can represent between €10 and €15/MWh. The French calls for tender had resulted in costs greater than €200/MWh.

wind are both more significant and more regular. An offshore wind industrial sector could be created, reinvigorating ports severely affected by the shipbuilding crisis, like Bremerhaven in the North Sea.

But for all that, despite these successes, German performance still needs to be put into perspective: the energy is only 12.6% compared to 10.4% in France. Fossil fuels still represent 80% of the total German energy mix, oil remaining very dominant in transport, and gas in industry and heating, revealing the extent of the journey still to be taken to achieve a zero carbon sector (graph 3 and table 2).

Graph 3 – Primary energy consumption mix in Germany and in France, 2016



Source: France Stratégie, according to Bilan France, Ministry for the Ecological and Inclusive Transition and AG Energiebilanzen

Table 2 – Share of renewable energy in primary energy consumption, France and Germany

2016		Germany	France
Renewables total		12.6%	10.4%
of which	Biomass*	7,3%	5,5%
	Wind	2,1%	0,7%
	Solar	1,2%	0,3%
	Hydropower	0,6%	2,1%
	Waste	1,0%	0,5%
	Geothermal	0,4%	0,1%

Source: France Stratégie, according to Bilan France, Ministry for the Ecological and Inclusive Transition and AG Energiebilanzen

The abandoning of nuclear by 2022: target maintained

The abandoning of nuclear is another emblematic target of the *Energiewende*, popular with a large section of the population. Seven nuclear plants were shut-down in April2011, making Germany the only country in the world that has permanently closed units that were still operational. Nuclear production accounted for 25% of the energy production before 2011, but it was still 14.2% in 2016, or 84.6 TWh. The timetable to shut down the remaining plants, which must be staggered up to 2022, is not being questioned. Between now and then, this stable and zero carbon energy production will need to be replaced, which would appear difficult without increasing CO_2 emissions, as an increase in intermittent energy capacity currently brings a risk to the stability of the electricity system and, in the absence of storage, it requires a recourse to conventional production means (see below).

Moreover, the very tense relationships which came about between the operators of plants and the government after the 2011 decision to accelerate the abandoning of nuclear, that the former consider plundering, seem to be settling. The Constitutional Court in Karlsruhe ruled in favour of RWE, E.On and Vattenfall which must be compensated in the region of a few billion dollars. The Court left it to the electricity providers and the government to agree on a definitive figure before spring 2018[6]. Another dispute was settled in June 2017 concerning the management of radioactive waste, the sum of 24 billion euros must be paid by the operators in exchange for avoiding their liability. Germany has still not decided on a definitive storage place for radioactive waste.

THE DIFFICULTIES ENCOUNTERED

The progress of the *Energiewende* has been compromised both by an electricity consumption that cannot be reduced much and by the position that the combustion-powered car and coal still occupy in the German economy. In 2014, on the day after the federal elections, the CDU-SPD coalition, aware of the need to curb expenses, modified the law on renewable energy (known as the EEG law[7]) to more strictly supervise the development of renewables.

6. Vattenfall, a foreign company, will see its appeal ruled on by an international court.
7. EEG, Erneuerbare-Energien-Gesetz (German law on renewable energy).

Energy efficiency is improving too slowly

Primary energy consumption is now lower, in the order of 6.5% compared to its 2008 level, but this result comes entirely from the reduction recorded in 2009, at the height of the crisis. Whereas it would need to reduce by approximately 3% per year by 2020 to reach the target given by the public authorities, it is stable and even slightly increased by 0.9% in 2015, which the German authorities explained due to the arrival of a million refugees in the country, then again by 1.1% in 2016, under the effect of lower temperatures and the leap year. The first half of 2017 confirms an increase of 0.8% compared to the first half of 2016[8].

Electricity consumption, for its part, has slightly decreased, going from 606 TWh in 2011 to 594 TWh in 2016. This reduction is driven by the residential sector, which accounts for 22% of the total, the consumption from industry and services remain very stable. The Germans have the means to equip themselves with high performing electrical goods and to insulate their homes, aided by favourable financing conditions. The very high price of the kilowatt-hour (KWh) – while the industry is profiting from low prices – and the campaigns encouraging savings do the rest. Without, however, stopping a growing disparity between Länder, the prosperous Bavaria has seen its electricity consumption increase by 30% over the last ten years.

A grand 17 billion euro energy efficiency plan for the 2016-2020 period was launched by the Finance Minister, Sigmar Gabriel, in mid-2016, accompanied by the publication of a green paper aiming to give a new impetus to energy savings and the thermal renovation of homes. In the long-term, the total energy consumption should, however, be encouraged to increase if Germany wants the transfer of certain uses to take place (electric vehicles, heat pumps, etc.), the only way to produce zero carbon energy. A study from the Fraunhofer Isi[9] institute even mentions a "considerable increase" in the electricity demand between 2030 and 2050.

The electric vehicle is colliding with the realities of the automotive industry

Transport remains the problem area, with 30% of the final energy consumed in Germany, essentially in the form of hydrocarbons. The Germans have long resisted the CO_2 emission standards that the European Commission wants to impose on vehicles and were still refusing, in April 2017, the supranational control of standardisation bodies proposed by the European Union. The affair of Volkswagen "rigged engines" and that of the deals between manufacturers have changed the game and, for the last two years been profoundly shaking up the German automotive industry, the central source of the economic wealth of the country, with nearly 800,000 jobs and a turnover greater than 400 billion euros.

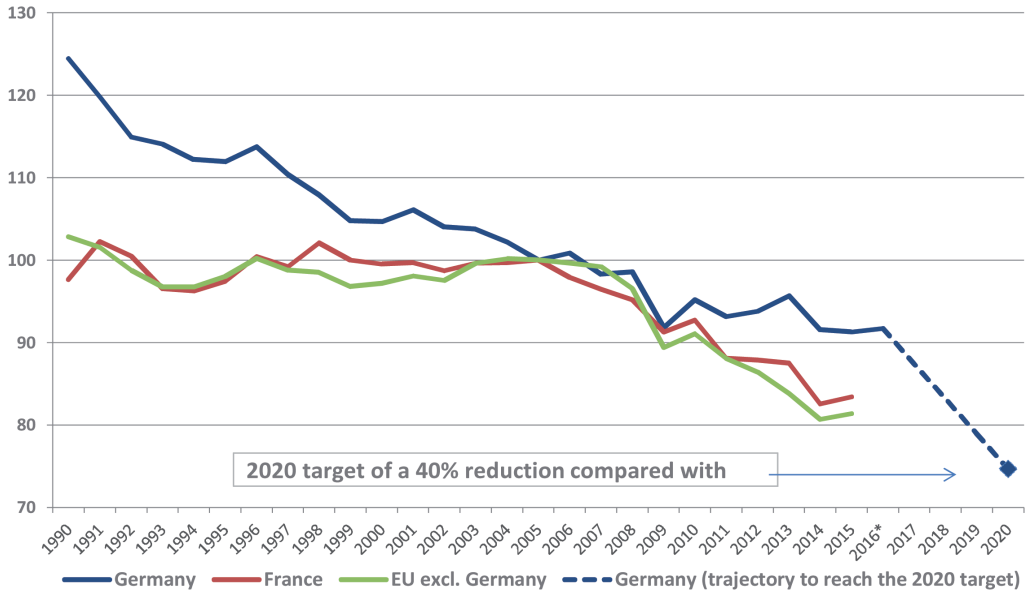
A wide-scale vehicle electrification plan was launched on paper in 2011, with the aim of 1 million electric vehicles (EV) by 2020, reaffirmed by the Chancellor in May 2013. This plan seemed to have been abandoned in May 2017, but Angela Merkel, in an interview on 17th August 2017, declared that she had not given up on it. For the moment, despite the aids, the increase in the number of EVs in circulation is not really taking off and was only 30,000 in 2015. The very high price of electricity in Germany provides an initial explanation for this failure, the cost of using an EV becoming close to that of an internal combustion vehicle while its purchase price is a lot higher. The lack of recharging infrastructure is also mentioned, but the real reasons seem more profound.

Industrially, a move to "all EV" plunges German car manufacturers into a certain disarray, their expertise relying essentially on controlling high performing engines and gearboxes, with a whole industrial fabric of SMEs making machines/tools constituting what is known as "Mittelstand". An EV is simpler to design and the central technological element relies on the battery, the manufacturing of which calls on other kinds of skills, in particular in electrochemistry. While the giant plant race is raging between Asia and the USA, with protagonists such as LG Chem and Tesla, the country seems to be hesitating faced with the extent of the task that getting such an industry on its feet represents.

From an environmental point of view, the German energy mix is very carbon heavy – 500 grams of CO_2/KWh, compared to 80 in France –, the carbon footprint of EVs is therefore not better than its combustion engine equivalent. As the manufacturing of batteries consumes a lot of energy, the country would have the additional difficulty of meeting its commitments if they were made on site. Hence the recent reminder from Angela Merkel: "To protect the climate, diesel cars are still as good today as they were yesterday and the day before yesterday[10]." At the start of July 2017, Martin Schulz, the SPD candidate for the chancellorship, came out on top by opposing the ban on diesel in cities and guaranteeing car manufacturer employees that he was the best placed to defend their jobs.

8. Source: Agora Energiewende.
9. Fraunhofer (2016), Netzentwicklungsplan Strom. *Entwicklung der regionalen Stromnachfrage und Lastprofi*, Karlsruhe, November.
10. "Angela Merkel verteidigt Diesel-Autos", *Frankfurter Allgemeine Zeitung*, 23rd March 2017.

Graph 4 – Comparative greenhouse gas emission development in Germany, France and the European Union (baseline of 100 in 2005)



Source: Eurostat and BMWi for the 2016 data, calculations France Stratégie

Faced with constant scandals, the image of diesel has been tarnished among the population and Germans stated that they were mainly favourable to banning its use in town centres. In order to restore confidence, Berlin established a national forum, the first meeting of which took place on 2nd August 2017. Following this, the manufacturers committed to update the software of 5 million of the most recent diesel vehicles, but also to provide 500 million euros of financing for "smart" mobility. They also announced a bonus of up to 2000 euros for the purchase of a new model in exchange for an old diesel vehicle. The Chancellor herself, now a candidate with a new mandate, declared in mid-August 2017 that she would no longer oppose a ban on the sale of combustion engine vehicles, like France or Great Britain, but did not mention a date. The situation is therefore very chaotic in the country, and the medium-long term future of its automotive industry has not been written, especially since, beyond issues of motorisation, the competition is playing out equally in terms of the autonomy and the connectivity of vehicles.

The difficult but necessary abandoning of coal

In the 1990s, greenhouse gas emissions remained stable in Europe, whereas those in Germany dropped by almost 20%: the reunification and the updating of very polluting facilities for the former GDR allowed Germany to achieve a large share of its targets cheaply. The trend was then reversed: while emissions from the EU began to decrease, Germany saw its emissions stabilise.

It now remains one of the biggest emitters of greenhouse gases in Europe with 11.5 equivalent tonnes of CO_2[11] per resident, compared to 6.5 equivalent tonnes in France (graph 4). According to BMWi themselves, Germany will soon miss its 2020 climate target. A study at the end of 2016[12] estimates that the country will reduce its emissions on this date by just 33.5% to 36.5% (instead of 40%). Indeed, the first half of 2017 indicates an increase in CO_2 emissions by 1.2% compared to the first half of 2016[13].

Responsible for approximately 25% of the country's total emissions, coal (including lignite) finds itself in the spotlight. Its share in electricity production is still very high, – approximately 40% –, as Germany has recently commissioned coal plants like that of the 1.6GW one in Moorburg near to Hamburg, and the 0.9GW one in Mannheim (table 3).

The country has considerable lignite reserves, exploitable at a low cost, which ensure the security of its supply. Replacing it with lower carbon gas implies securing its supply. Commissioned in 2011, the Nord Stream gas pipeline, transporting Russian gas directly under the Baltic Sea, was opportunely integrated into the *Energiewende*[14]. But since the Ukrainian crisis, Germany has seemed less

11. Equivalent ton of CO2.
12. https://www.bund.net/fileadmin/user_upload_bund/publikationen/klimawandel/klimawandel_zusammenfassung_klimaschutzluecken_2020.pdf
13. Source: https://www.agora-verkehrswende.de/presse/newsuebersicht/co2-emissionen-legen-im-ersten-halbjahr-2017-zu-1/
14. Beeker É. (2012), "La transition énergétique allemande est-elle soutenable ?" (Is the German energy transition sustainable?), *Policy brief*, no, 281, Centre d'analyse stratégique, September.

confident in the security of the supply which Russia ensures for it[15], even though this is not preventing it from supporting the Gazprom project to build a second gas pipeline, Nord Stream2, alongside the first. This project appeared to numerous stakeholders, including Germans, as contrary to all the shared principles on which the European Union has agreed in terms of energy and foreign policy, and is subject to a fierce legal battle undertaken by the Eastern European countries and Italy as regards its compliance with European law. The Germans alleged that it was a private interconnection with a state outside of the EU. Things got complicated again during the summer of 2017, with the USA threatening sanctions for countries trading with Russia, with the thinly-disguised aim of opening up the European market to their non-conventional gas.

Table 3 – Electricity production by sector in Germany and in France, 2016

2016	Germany		France	
	TWh		**TWh**	
Nuclear	84.6	14.2%	384.0	81.2%
Oil	5.9	1.0%	3.3	0.7%
Coal	111.5	18.8%	7.3	1.5%
Lignite	150.0	25.2%	0	0.0%
Natural gas	80.5	13.5%	35.3	7.5%
Others	27.5	4.6%	6.7	1.4%
Total Renewables	188.2	31.7%	94.7	20.0%
of which Biomass	44.9	7.6%	6.5	1.4%
Wind	78.6	13.2%	20.7	4.4%
Solar	38.1	6.4%	8.3	1.8%
Hydropower	20.5	3.4%	59.2	12.5%
Total production	648.3		531.3	
Consumption	594.6	100%	473.0	100%

Interpretation: Raw data for Germany, cumulated for France[16].
Source: AG Energiebilanzen (provisional data), RTE

Under these conditions, it is understandable as to why the French proposal in June 2017, to establish a floor price for carbon on a European level, was rejected in Germany, despite the fact that this measure would speed up the substitution of coal with gas. The Germans oppose the very significant competitive advantage that such a floor price would grant to French nuclear power plants. For the Pöyry[17] firm, a CO_2 price of €30/ton would bring the marginal operating cost of coal plants from €35/MWh to €55/MWh and that of the best performing gas plants from €39/MWh to €47/MWh. The price of a KWh for German manufacturers would increase by 40% following the price rise in the wholesale market which they supply. The gain for EDF, which sells over 400 TWh of zero carbon electricity on this market, could be calculated at billions of euros per year. Only the Greens supported the French proposal, the FDP (liberals) and the SPD rejected it in order to protect the interests of German industry.

On the domestic political scene, the abandoning of coal, after nuclear, is becoming the main issue for debate on the energy transition. The eventual closing of the coal plants is a contested target: the Greens are asking for a complete end to coal by 2036, while the BDI (Federation of industries) see a danger in it for German industry, the left-wing parties highlight safeguarding employment for young people and plant jobs. Despite all of this, Germany successfully published its climate plan at the very last moment for COP 22 in Marrakesh: without concrete measures, this Klimaschutzplan 2050 focuses on advocating for a gradual abandoning of coal, due to the fact that the economy of whole regions depends on its exploitation. This industry employs approximately 33,500 people (mining and electricity production combined), whereas when its abrupt closure was decided upon, the nuclear industry employed 40,000. "We cannot abandon coal and nuclear at the same time", Sigmar Gabriel declared in 2004. Indeed, this fuel, intimately linked to the formidable German industrial success for a century and a half, cannot easily disappear from its energy landscape.

TWO MAJOR CHALLENGES WHICH RISK CREATING RESISTANCE FROM THE POPULATION

The abandoning of coal goes back to the question of long-term supply security which falls within geo-politics. But in the short-term, Germany is also threatened by considerable amounts of intermittent renewable energy which weaken the electricity system, leaving "black-out" threats looming. According to diverse estimates[18], the sums committed in Germany to the energy transition have already reached 500 billion euros. Other expenses are on the horizon and uncertainty reigns over the population's ability to accept them.

15. See for example Hans-Werner Sinn (2014), "Putin and flickering Power", *Ifo Viewpoints*, no. 154, March.
16. The total electricity production is that measured on output from the plants, in other words a deduction made from the consumption of auxiliary services and losses in the plant transformers.
17. Cabinet Pöyry (2017), "Europäischer Mindestpreis für CO2-Zertifikate: Energie-Experten befürchten massive Strompreiserhöhung durch Macron-Pläne", June.
18. Like those from the university of Düsseldorf, cited for example in *Die Welt*, 10th October 2016.

The complex balance of the electricity system

Managing the intermittence in renewable energy production

The absorption of growing quantities of intermittent energy has become problematic, as the storage options are almost non-existent. Despite recent progress, electrochemical batteries remain too expensive and cannot ensure inter-seasonal storage (from summer to winter). A great deal of hope was placed in hydrogen, but the cost of electrolysis is prohibitive and its efficiency is too low[19]. The number of hydraulic storage facilities in the country is limited and the economist, Hans-Werner Sinn[20] has shown that their number would need to be increased by 200 to incorporate all the intermittent energy planned. Not only would hundreds of billions of investment be required, but, above all, the geography of the country does not allow it for lack of available alpine sites.

The installed capacity in renewable alternative energy sources[21] and intermittent ones, wind and solar, is 90GW, well above the average German demand (65GW) and especially that of the summer weekends (40GW). The incidences of overproduction are therefore frequent, occasionally creating negative prices on the wholesale electricity markets[22]. Yet, above all, very variable electron flows threaten the stability of the electricity system, which requires grid managers to regularly use exceptional measures like redispatching, which consists of stopping renewable energy and "curtailment", when its production cannot be carried away by the grid or absorbed by local demand. The costs incurred become significant, spread between the indemnities to pay to producers of renewables and the costs of grid congestion[23], but, above all, they will increase more quickly than the share of intermittent renewable energy.

Conversely, in the absence of wind and sun, the situation can become very tense, like in January 2017[24]. The shutting down of nuclear plants in France and the low levels in the Swiss and Austrian dams worsened the situation, fresh evidence, if any more was needed, of the interdependence of the European electricity systems. The situation can only grow more strained in the years to come, the BNetzA, the German grid regulator, has identified that 3.5GW of conventional plants, mainly gas, must be built before 2019, whereas 6.3GW must, at the same time, be downgraded. Between 2020 and 2022, the six final nuclear plants still in operation must be stopped, in total, this equates to 8.1GW of guaranteed additional power which will be missing. The four TSO's (Transport System Operators: Tennet, Amprion, TransnetBW and 50Hertz) published, in March 2017, a study which shows that the margins – or the gap between the maximum power available and the peak in demand – should turn negative after 2021[25].

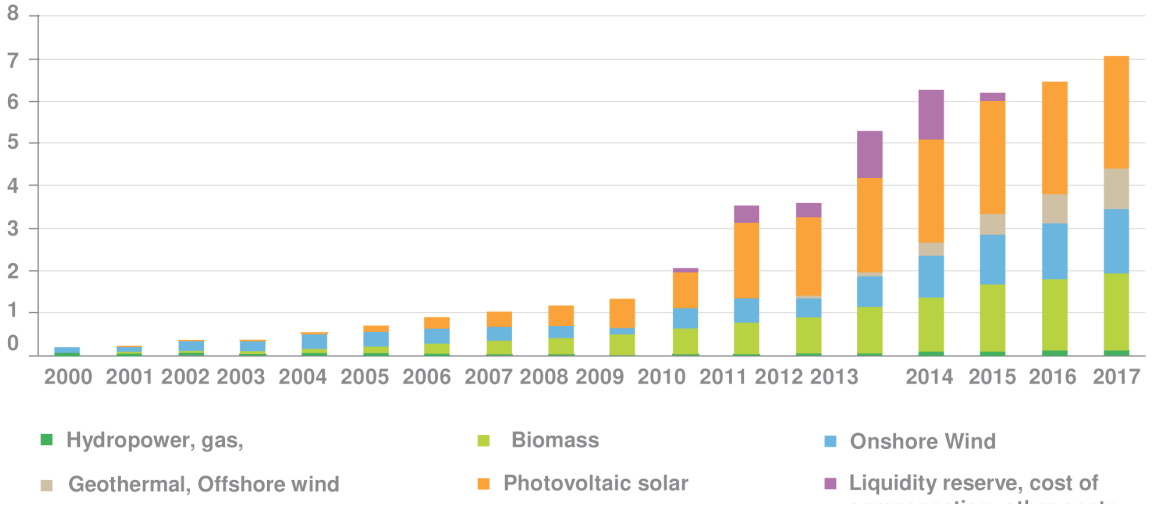
Germany has not experienced a significant power failure since November 2006[26] and the quality of the supply remains, globally, very good. Nevertheless, mounting apprehension is beginning to be felt among the public and within certain local authorities like the town of Dresden, which has trained its civil protection units to cope with the consequences of a black-out[27].

The construction of high voltage lines is not keeping pace with that of renewable energy

In order to limit the congestion, the consensus and the priority are in strengthening the grid, as the wind resources in the north of the country are geographically far from the major consumption centres, in particular the over-consuming industrial south[28]. One of the paradoxes that is often not realised in terms of the *Energiewende* is that it has made the Länder more dependent on one another, while it was meant to re-enable the former decentralised energy model around local bodies. Yet the construction of lines is slow. The grid development plan, created at the end of 2014, estimates that 7,700 kilometres are high priority. The BNetzA noted in its report of May 2017[29] that only 850 kilometres of new lines had been deployed since this date, of which only 90 in 2016. The population is vehemently opposed to the placing of lines in order to pro-

19. At best, 30% of the energy store is returned, compared to 90% for batteries. See Beeker É. (2014), "Y a-t-il une place pour l'hydrogène dans la transition énergétique ?" (Does Hydrogen Have a Place in the Energy Transition?), *Policy Brief*, no. 15, France Stratégie, August.
20. Hans-Werner Sinn (2016), "Buffering volatility: a study on the limits of Germany's energy revolution", Cambridge-MA, July – http://www.nber.org/papers/w22467
21. Said of a method, the energy production of which cannot be control
22. The paper from CAS in 2012 was one of the first to mention this phenomenon.
23. *Monitoringbericht 2016*, Bundesnetzagentur.
24. https://www.amprion.net/Presse/Presse-Detailseite_9280.html
25. Negative margins indicate a possible supply deficiency. The power guaranteed by each sector during consumption peaks is evaluated according to a statistical approach. That of PV solar is non-existent, whereas wind is very low.
26. On 6th November 2006, a high voltage line was cut deliberately in the north of Germany while the wind production was very significant, which led to cascading outages in all Western Europe.
27. *Dresdner Neueste Nachrichten*, 26th July 2017.
28. Bavaria has a pipe dream of engaging in its own *Energiewende* in order to ensure the security of supply to the industrial sites which generate its wealth.
29. The grid development plan, NEP (Netzentwicklungsplan), created at the end of 2014.
30. www.netzentwicklungsplan.de 2nd May 2017.

Graph 5 – Surcharge for renewables in euro cents/kWh in Germany per technology (EEG-Umlage)



Source: BMWi

tect the landscape, as the Länder that are crossed often do not benefit from the current transported or the revenue associated with the production of renewable energy. At the end of 2015, the authorities took the decision to bury the lines, without succeeding in quelling all the resistance. The estimated development costs of the grid are in the tens of billions of euros[30], both for the VHV grid and for local distribution, not forgetting the investments required to connect to the offshore wind farm.

For the consumer, after the share supporting renewables, the proportion of the grid in the price of the kWh has begun to increase significantly. Furthermore, the price gaps between Länder and even Stadtwerke (municipal services) have been widening in an unequal manner, requiring the government to announce that it was going to standardise the grid contributions from 2019, therefore moving towards a French style equalisation.

In the meantime, the European system is called upon

As other means of transportation are being sought for electricity flows, physical exchanges with abroad are increasing in volume and frequency, with Germany basing the stability of its grid on those of its neighbours. Flows called "loop flows" only cross certain countries to transport the current from the north to the south of Germany, disturbing grids that are often vulnerable. Within the ENT – SOE (Association of European Transmission System Operators), the Germans are very present and advocate for community funds to be, in part, dedicated to funding the grids required by the development of electricity from renewable sources[31].

This dependency in terms of the grids of neighbouring countries shows that the German energy model cannot be generalised[32], but also that European coordination between energy transitions is becoming an urgent necessity.

A high cost borne by the small consumers

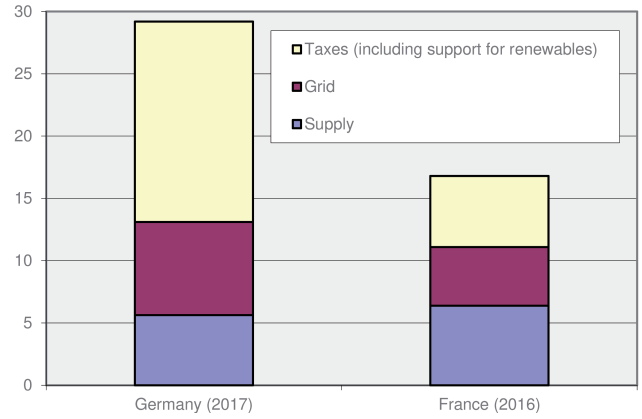
The Federal Court of Auditors in a report from August 2014, estimated that "the governmental project [of *Energiewende*] was onerous, disorganised and incoherent, criticism which was repeated in January 2017. The sharp increase in the prices of kWhs is, undoubtedly, the most visible consequence for the Germans, the support for renewable energy now costing over 300 euros per year for an average family of four people[33]. The tax which finances renewable energy is constantly rising, reaching 7 euro cents per kWh in 2017, and all of the taxes now account for over 50% of the total price (graph 5). This cost is entirely carried over to the price of the kWh for small consumers which is reaching 30 euro cents / kWh compared to 16 euro cents / kWH in France (graph 6). Big industry is exempt from this tax, as the government, with the support of the population, is concerned with preserving its competitiveness.

Faced with a high price for electricity, households which can call, at least partially, on self-consumption, therefore escape taxes (which account for 55% of the price of the kWh) and grid costs (25% of this price). According to the

30. www.netzentwicklungsplan.de 2nd May 2017.
31. Cruciani M. (2015), "Réseaux électriques et transition énergétique en Europe" (Electrical grids and energy transition in Europe), *Paper from the IFRI*, June.
32. C. Mandil talked of the "non-Kantian" transition as it cannot be applied to others.
33. Source Verivox.
34. Franco-German Office for the energy transition.

OFATE[34], this practice would concern 20% of the 1.5 million homes equipped with solar panels. In order to make access to electricity to as many people as possible long lasting, parties like the SPD are offering, in their programme, to overhaul the financing of the energy transition to have it borne by the budget of the State or the one for fossil fuels.

Graph 6 – Electricity prices for residential consumers in Germany and in France (euro cents / kWh)



Source: France Stratégie, data from the BNetzA and the CRE

A SLOWING DOWN AFTER THE FEDERAL ELECTIONS?

As the Federal legislative elections approach on 24th September 2017, what is the major German parties' understanding of all these overlapping challenges?

The Green party (Die Grünen) remains historically the most ardent promoter of the *Energiewende*. Yet, its political weight has diminished after a significant fall in the regional elections at the start of 2017. Abandoning nuclear, its first demand, has now been achieved, as the country is now widely covered by solar panels and wind turbines, but the abandoning of coal is not an issue that is as much of a consensus among the population. The major parties have taken up ecological themes in their programmes and citizens do not attribute particular competencies to ecologists over their main concerns which are security, terrorism, refugees, the new commercial policy of the USA and even the future of Europe, etc.

In contrast, the AfD (*Alternative für Deutschland, the right-wing populist party*), which has a good chance of entering the Bundestag, published a government programme in March 2017 in which the energy question was quickly addressed. It advocates quite simply abandoning the Climate Plan and the *Energiewende*, which "funds grants going to a few profiteers [...] to the detriment of modest -income households". The threats on the security of the electricity system, the risks of black-outs, as well as the impact on the landscape are also evoked to put a stop to the development of renewables.

The SPD, for its part, generally highlights innovation and the need for performance from the German economy. The grants must be examined according to th eir impact on the climate. The importance of fossil fuels, in particular gas, to the success of the energy transition is confirmed and the idea of the carbon floor price, briefly considered, has finally been abandoned.

The programme from the conservative block (CDU/CSU), Angela Merkel's party, is unveiling few concrete measures. It reaffirms the government's climate targets, but does not advise additional measures, despite the significant delay in its roadmap for 2020. It also advocates for a continuation in the shrinking of subsidies on renewable energies, without going into details.

The CDU is followed in this by the FDP (liberals), with whom they have formed a coalition government in the Land of North Rhine-Westphalia. Their policy, which could foreshadow what they would apply on a federal level if the two parties were to have to get on in a coalition after the legislative elections, are openly pro-fossil and intend to bring about a complete reversal of the *Energiewende*[35]. On the programme is the cessation of grants for renewable energy and the priority that is given to them on the grid, as well as measures destined to put the brakes on the development of wind, such as increasing the minimum distance between residents and turbines.

An energy transition lasts, let's say, approximately ten to fifteen years. The Germans have been held in suspense on these questions since the start of the 2000s and are not paying the same attention to it as they were five years ago. For many of them, the effort has been put in, the *Energiewende* is on track and its steering is nothing more than a technical question. The political management of the necessary "turnaround in the energy turnaround[36]" is very delicate, but also benefits from a period of relative disinterest from voters, ideal for major reorientations.

34. Franco-German Office for the energy transition.
35. Interview of the Regional Minister for Energy, Andreas Pinkwart, in the *Handelsblatt Global* on 21st July 2017.
36. "*Energiewende*", translated literally means "energy turnaround".

CONCLUSION

While it occupies a central and economically dominant position in Europe, Germany committed, in 2011, to a radical turnaround in its energy policy, the *Energiewende*. This plans for the abandoning of nuclear and fossil fuels and their replacement by a mix made up almost exclusively of renewable energy, with the aim of an almost complete zero carbon economy by 2050. Six years after its launch, this energy transition has led to an accelerated development of renewable energy, which now accounts for a third of electricity production, an undeniable technical feat. Yet the aim of creating a global leading industry in PV solar has failed, ending in the loss of 100,000 jobs since 2013. At the same time, numerous observers, including those from circles close to the government, recognise that Germany cannot meet the targets in terms of reducing greenhouse gas emission that it set itself for 2020, and that, in the long term, uncertainty remains at a very high level.

Indeed, energy efficiency is improving too slowly, transport continues to use oil and the electricity plants continue to burn the same amounts of coal and lignite. The bill presented to the consumer remains very high for the increase in the power of renewable energy that has already been accomplished, approximately 25 billion euros per year, over a period of twenty years. The renewable energy which is being developed now is still supported financially and unforeseen associated costs, poorly quantified but very significant, have appeared in the construction of lines and the maintenance of grid security. But more worrying still, in the short term, is perhaps the security of the supply, as the grid is currently weakened by massive uncontrollable and intermittent flows of electrons when solar and wind are at full operating capacity.

The *Energiewende* still enjoys strong popular support and remains, for many Germans, a great social project, even if they no longer follow these energy questions as attentively, since they have become technical and very complex. The programmes of different parties seem to indicate that the political leaders are very aware of the challenges that the energy transition faces. At a time when the voters' attention is on other issues, like immigration and security, we can expect a scaling back of the German energy policy ambitions after the federal elections next September.

Key words: Energy transition, ecological transition, Energiewende, German federal elections, energy policy, Germany, renewable energy, black-out, abandoning of nuclear, abandoning of coal, climate targets, electric vehicles

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