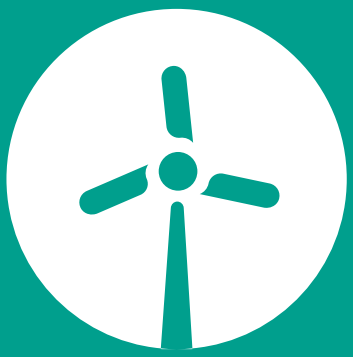

GERMANY

ELECTRICITY AND HEATING

Germany, a model under construction?

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CLIMATE CHANCE

Germany, a model under construction?

At the turn of the 2000s, Germany embarked on a transformation of its electricity production that is still ongoing today. While the fight against climate change requires rapid decarbonation of the overall electricity mix, the energy transition led by the world's fourth largest economy is one of the few large-scale experiments which can be used as a model.

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CONTENTS

1 • THE EVOLUTION OF THE GERMAN ELECTRICITY SECTOR

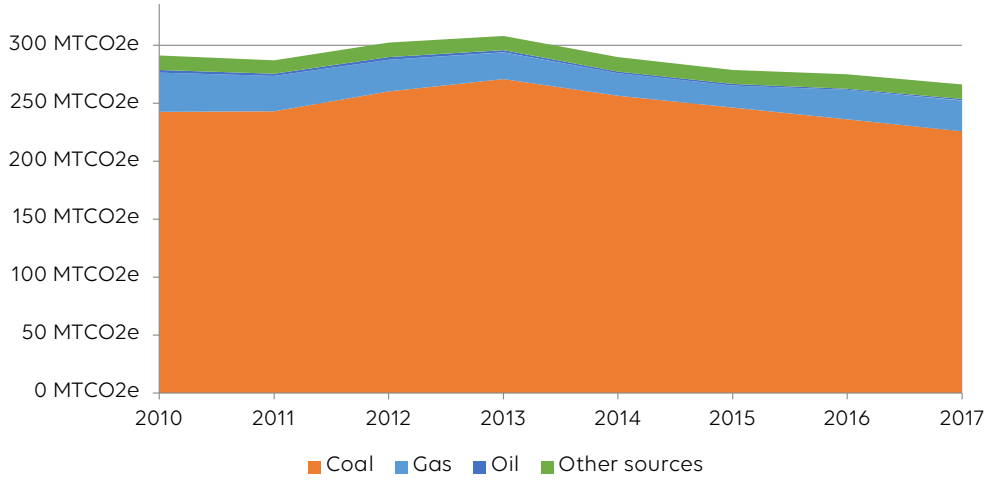
• DOWNWARD-ORIENTED ISSUES • In 2016 and 2017, emissions related to electricity and heat production in Germany decreased by 3.9 and 8.9 CO_2 mteq, respectively.

This decline, which came after an increase in 2011 to 2013, confirms a long-term downward trend observed since the 1990s, the rebound in the early 2010s being explained by cyclical causes: the return of growth after the 2008 crisis and acceleration of the shutdown of nuclear power plants in the aftermath of the Fukushima accident.

Since 2013, the sector's emissions have begun to decline again at a steady pace: between 2013 and 2017, annual emissions fell by 41.4 CO_2mteq or 14.2%. This decrease is due to the decline in emissions from coal-fired power plants (-45.1 CO_2mteq/ year between 2013 and 2017) partially offset by increases in gas use (+ 3.7 CO_2mteq/ year). This gas-coal substitution has accelerated over the last two years.

The fall in emissions is even greater when compared to the amount of electricity actually generated. Indeed, German electricity generation has increased markedly over the last twenty years, from 576.6TWh in 2000 to 654.8TWh in 2017. This increase has seen Germany, an importer of electricity in the late 90s, become the largest electricity exporter in Europe.

Between 2015 and 2017, German electricity generation increased further by 6.7TWh. Consequently, while electricity sector emissions fell by 4.6% over this period, the carbon intensity of electricity declined even more rapidly: in 2017, generating a megawatt hour of electricity in Germany emitted 5.6% less CO_2 than in 2015.



	2013	2014	2015	2016	2017
Total	306.2477	288.6509	277.6279	273.7003	264.8552
Coal	270.9566	256.3565	246.2193	236.3306	225.8448
Gas	23.0119	19.5899	19.3029	25.149	26.7576
Oil-based products	1.9132	1.3156	1.293	1.2058	1.2125
Other	12.2792	12.7045	12.1057	12.2207	12.2528

FIGURE 1. EMISSIONS FROM ELECTRICITY GENERATION AND URBAN HEAT BY FUEL ($MTCO_2E$)

(source : Enerdata)

• A REMARKABLE EVOLUTION OF THE ELECTRICITY MIX • This drop in emissions and carbon intensity is significant, but it is not commensurate with the evolution of the German electricity mix, which has undergone a profound transformation over the past two decades.

Since 2000, Germany has experienced a rapid development of renewable energies, from just a

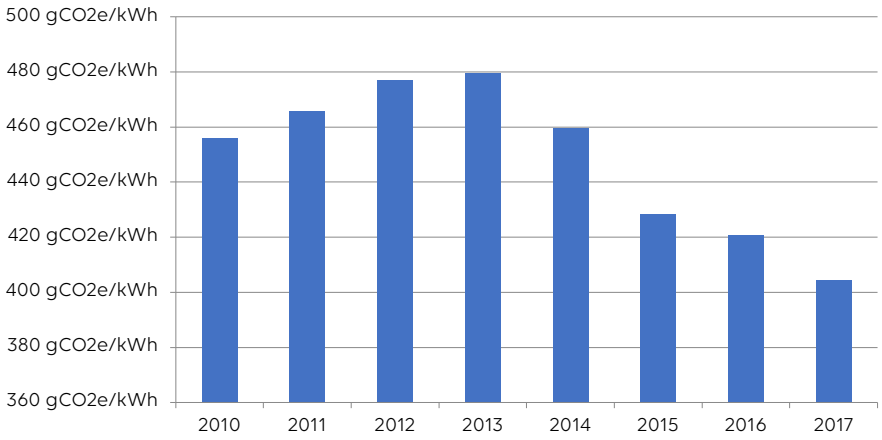


FIGURE 2. CARBON INTENSITY OF GERMAN ELECTRICITY

Sources : Enerdata and AGEB

few percent to today, when they represent more than one third of the electricity mix. This increase has more than offset the 3-fold decline in the share of nuclear power, which led to a 10-point drop in the share of fossil fuels in the electricity mix.

These transformations have continued in recent times. Between 2015 and 2017, renewable energies increased from 29.1% to 33.3% of the electricity mix and even to 40% in the first 35 weeks of 2018 (Energy charts, Fraunhofer Institute). This change is being driven mainly by the development

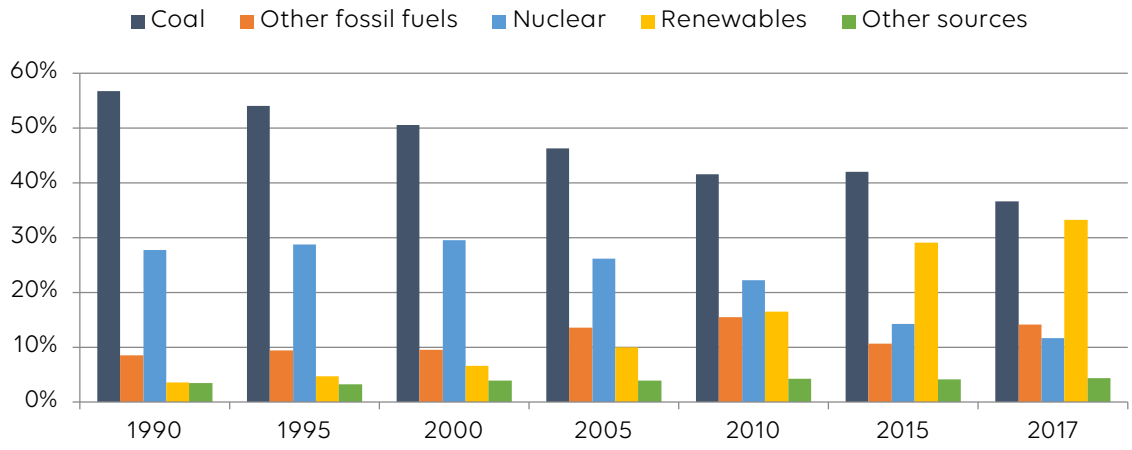


FIGURE 3. EVOLUTION OF THE GERMAN ELECTRICITY MIX

(Source: AGEB)

of off-shore wind power, for which generation has more than doubled in 2 years.

At the same time, coal (-5.4 points) and nuclear power (-2.5 points) continued to decline. The decline of coal is slower for lignite, which pollutes more but is produced locally, than for bituminous coal, which has all been imported since the closure of the last two German mines in 2018: -1.3 points in 2 years for lignite vs. -4.1 points for bituminous coal. Finally, the last two years have seen a rapid increase in gas, which has increased by 3.6 points in the German electricity mix. This increase is not entirely new but it accelerated sharply in 2016.

2 • A STRONG POLITICAL IMPULSE

This evolution of the German electricity mix is the result of an energy policy devised in the 1980s and continued throughout the 2000s despite unforeseen circumstances and political alternations.

• BUILDING AN ALTERNATIVE AND A CONSENSUS • In the 1980s, the German electricity mix was dominated by fossil fuels (about 65% with a large majority of coal) and nuclear (about 30%) with a small share of renewables, mainly hydroelectric.

It was at this time that the energy transition project that Germany is now implementing began to take shape. This shift originated in the anti-nuclear movement, which was very active in the 1970s. In the mid-1980s, it achieved its first success with a moratorium on the construction of new reactors. In connection with economic actors investing in renewable energies and part of the government, the movement then began its metamorphosis towards an energy and political project that was an alternative to the traditional pro-coal position of the SPD and pro-nuclear position of the CDU/ CSU (Aykut, 2015).

In East Germany, the environment was at the heart of the challenge of the communist model: the Umweltbibliotek («environmental library») was created by dissidents in East Berlin in 1986 and dismantled the following year by the Stasi. Reunification gives Germany the opportunity to rethink its industrial fabric. In the East, energy demand collapsed with heavy industry, five nuclear reactors closed and thermal power plants were modernised.

An important step was taken in 1990, when the Kohl administration established a guaranteed purchase tariff and priority access to the network for renewable energies. These principles are the two foundation blocks of the German energy transition. At the turn of the millennium, the consensus in favour of a gradual exit from nuclear power was sufficiently strong for it to be ratified by the Convention of 14 June 2000. This agreement between the ruling Green-SPD majority and the four nuclear power plant operators, limits the amount of electricity that can be produced by German reactors. The closure of the last of them was then planned for 2020. At the same time, the *Erneuerbare-Energien-Gesetz*, the law on renewable energies, allows for an acceleration of new installations, notably solar and wind.

This policy was initially criticised by the right which campaigned for an «exit from the exit». But the slogan was not reflected in practice: In 2010, while the CDU/ CSU governed without the SPD or the Greens, the Energiekonzept, a major law on energy, set ambitious targets for the middle of the century - a 50% drop in primary energy consumption in 2050 compared to 1990, an 80% reduction in emissions, an 80% share of renewables, etc. - and put back the end of atomic power to 2036. The timetable for the exit from nuclear was relaxed but the principle was not questioned.

• POST-FUKUSHIMA • This postponement of the exit from nuclear was fleeting: the following year, the Fukushima catastrophe persuaded Angela Merkel to think again. As of 15 March, 2011, 4 days after the earthquake, the law extending the lifespan of the power plants was suspended and 7 reactors were shut down by decree. The Energiewende, a new «energy package» of 11 laws, was passed by the Bundestag in June 2011 by a very large majority.

These texts return to a definitive end for nuclear power in 2022 and accelerate the process by confirming that the 7 decommissioned reactors, plus the Krummel reactor, which was experiencing repeated failures, would not be recommissioned. They also planned to reduce electricity consumption by 10% between 2010 and 2020, to double renewable production to 35% of the electricity mix in 2020 and to spend 3.5 billion euros on renewable energy research between 2011 and 2014 (an increase of 80% compared to the previous period). Finally, they confirmed the renewable targets and emission targets for 2050.

This policy comes at a cost: 15 to 40 billion euros per year or 0.5 to 1.2% of German GDP (Agora Energiewende, 2017), 60% of which is borne by households. Despite these investments, Germany will

largely miss its emissions targets for 2020 (BMU, 2017): the country targeted 751 CO_2mteq in 2020, or -40% compared to 1990, but it was still at 905 in 2017. This failure is not attributable solely to the electricity sector, which accounts for only one third of German emissions, but it does cast doubt on Germany's exemplary nature in this area.

Be that as it may, the political consensus around the German energy transition was completed by the volte-face of the main right-wing party in 2010-2011 and it remains solid - only the far-right party AfD today voices any opposition to this project. For its part, the vast majority of the population supports this policy: 93% of Germans think that the *Energiewende* is important, only 8% think that renewable energy is developing too quickly and 58% think, conversely, that it is too slow. The Germans are optimistic about the next stage of their energy transition: 63% think that it will be possible to replace coal-fired power stations with renewable production (BDEW, 2018).

3 • THE ROLE OF CIVIL SOCIETY AND SUB-NATIONAL ACTORS

In spite of these difficulties, unforeseen circumstances and political alternations, for nearly 20 years Germany has followed the energy policy which it defined in 2000. The electricity mix is evolving slowly, but this stability is indispensable to its transformation. It is largely explained by the role that non-state actors have played in the design and implementation of the country's energy policy.

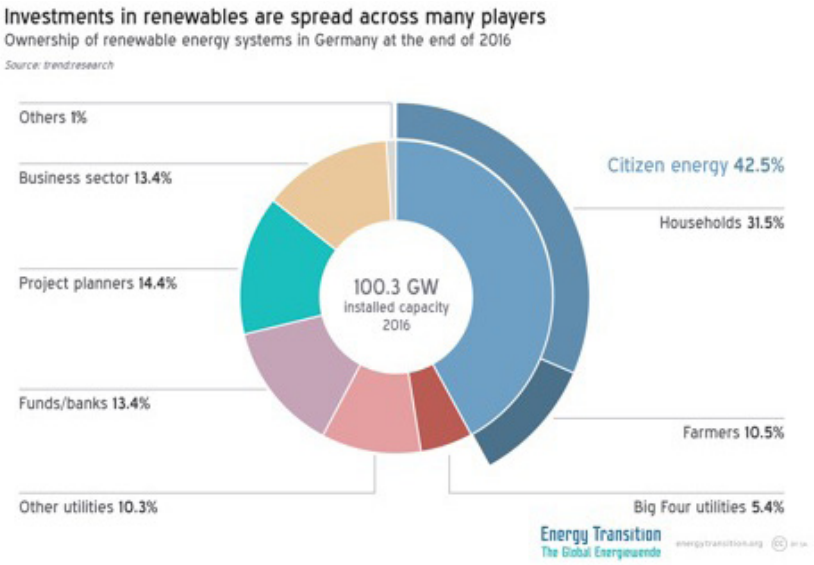


FIGURE 4. TYPES OF INVESTORS IN GERMAN RENEWABLE ENERGY PROJECTS (ENERGY TRANSITION)

(Energy Transition)

• CITIZENS, COMMUNITIES, NGOS ... THE ROLE OF LOCAL INITIATIVES • Building on a tradition of local energy management, the development of renewable energies has led to the emergence of numerous cooperatives and a reappropriation of electricity production by consumers. Today about half of renewable capacity is privately owned or farmed, compared to only 5.4% for large energy companies (Trend Research, 2017). This ownership of the energy transition by local communities promotes project buy-in and redistributes part of the costs of the German energy policy.

Local initiatives are not limited to seizing the development opportunities offered by the energy policy decided at the federal level - it often goes much further: many communities are committed to achieving 100% renewable energy or carbon neutrality.

The Baden Wurtemberg energy and climate policy

Located in the industrial heartland of southwestern Germany, the Baden Württemberg Land is one of the most prosperous regions in Europe. It contributes about 0.3% of world greenhouse gas emissions.

In its 2013 climate protection law, Baden Württemberg set itself the goal

of reducing its greenhouse gas emissions by 25% between 1990 and 2020 and by 90% by 2050. These objectives are to be achieved at the same time as the exit from nuclear, on which the Land is historically highly dependent: atomic power provided 48% of its electricity in 2010. To compensate for the disappearance of nuclear, it has targeted 38% renewable electricity in 2020, 12% of which is solar and 10% wind, and 86% in 2050. Its regulations have been revised to this end - planning rules, for example, have been relaxed to accommodate the installation of wind turbines.
To reconcile industrial prosperity and climate protection, energy will also have to be used more efficiently. The Energiekonzept 2020, adopted by Baden Wurtemberg in 2007, provides for a reduction in the energy intensity of the local economy of 2% per year. Electricity demand will be stabilised and primary energy consumption will fall. Several initiatives have been launched to achieve this, such as the Zukunft Altbau to raise the awareness of homeowners, the energy check (EnergieSparCheck) that co-finances the study of energy efficiency in the residential sector and the KlimaschutzPLUS scheme which subsidises local investment in the renovation of public buildings.
In 2008, Baden Wurtemberg was the first Land to pass a law on renewable heat. This law imposed a share of renewable energy in the heating for any renovation of residential buildings.

Sources : Ministerium für umwelt, klima und energie wirtschaft baden-württemberg

TEXT BOX 1

These proposals are not always unanimously accepted. In this case, German civil society is also able to reclaim political and economic ownership of the levers for the specific implementation of the energy transition at the local level.

The battle for control of Berlin's electricity grid

To overcome the resistance of some companies and communities, it is sometimes necessary to control the distribution network. This strategy was initiated by the «Schönau rebels» who took control of electricity distribution in a Black Forest village in 1997. Today Elektrizitätswerke Schönau, the company created for the occasion, supplies more than 30,000 homes with renewable energy.
The same battle is taking place on a different scale in the German capital. Privatised in 1997, the Berlin power grid became the property of the Swedish electricity company Vattenfall at the beginning of 2001. The Berlin Senate, theoretically responsible for the regulation of the grid, rarely exercised its powers and the local authority was regularly criticised for its failure to act, while the development of renewable energies would require a modernisation of the electricity grid. In the early 2010s, Berlin was ranked last for the integration of renewable energies and the capital was still mainly supplied by 3 coal power plants.
In response to this situation, two citizens' initiatives were put in place to regain control of the grid: the Berliner Energietisch, formed in summer 2011, and Bürger Energie Berlin, created in December 2011.
In pursuit of the same objective, these two initiatives illustrate different means of action available to German citizens. The Berliner Energietisch is an informal collective of associations and citizens that set itself the goal of imposing stricter regulations on the grid operator through a popular referendum. Bürger Energie Berlin is a cooperative whose goal is to take direct control of the grid, initially when the concession was renewed in 2014. These strategies also correspond to different forms of citizen engagement: participative demo-

cracy in the first case, cooperative economy in the second.
The Berliner Energietisch initiative sought to collect 20,000 signatures in 4 months for submission to the Berlin Senate. It collected 30,000 but the project was rejected due to opposition from the majority CDU. 172,000 signatures were needed to reverse this decision - 228,000 were collected, forcing the authority to hold a referendum. This was originally scheduled for 22 September 2013 at the same time as the parliamentary elections but was postponed until 3 November, which made it possible to defeat the proposal: although 83% of voters, or 24.1% of those registered, voted for the proposal, at least 25% of registered voters were required for its adoption.
In 2014, Bürger Energie Berlin raised nearly 12 million euros from 2,500 Berliners, which enabled it only to make an offer for a minority stake in the distribution grid. The call for tenders was again awarded to Stromnetz Berlin, a subsidiary of Vattenfall.
The battle continued with the 2016 election of a new SPD - Die Grünen - Die Linke majority which was in favour of remunicipalisation.

Sources : www.buerger-energie-berlin.de et Blanchet, 2014

TEXT BOX 2

• INTENSE ACADEMIC ACTIVITY • The design of the German energy transition is the result of groundwork carried out in part by universities and think tanks. Since the 1980s, the Öko-Institute, a research institute specialising in the field of the environment and from the anti-nuclear movement, has published a book entitled: «Energiewende: Growth and prosperity without uranium or oil» (Buchan, 2012).

Technical research organisations have played a key role in the development and demonstration of renewable technologies. For example, in 1987 the Fraunhofer Institute created the first European mountain refuge entirely powered by solar power (the Rappenecker chalet in the Black Forest). In 1992, the Fraunhofer built the first solar house not connected to the electricity grid in Freiburg, to demonstrate that a family can meet its domestic energy needs from renewable energies.

Today Germany has some of the most influential energy policy research organisations: Fraunhofer Institute, Agora Energiewende, Adelphi, Potsdam Institute, etc. These bodies help to shape the German energy transition and energy exports.

• SEEKING ALLIANCES WITH ECONOMIC ACTORS • The German energy transition is inseparable from the emergence and development of companies specialising in new energy technologies: these entities contributed to the design and promotion of the project in the 1990s and were able to change scale thanks to the rapid development of renewable production from 2000. The energy policy has therefore had the side effect of making Germany one of the industrial champions in the field: in onshore wind, for example, three of the top ten global manufacturers are German (BNEF, 2017). It is also a source of employment: in 2015, the renewable energy sector employed more than 300,000 Germans, twice as many as in 2004 (BMWI, 2016) - which is why German workers' unions generally support the project while keeping a watching brief on its effect on the fossil fuel sector.

The role of unions

The powerful German unions are important energy transition stakeholders. They have national influence because of their traditional alliance with the Social Democratic Party, but their members are also often active in implementing the transition on the ground.
German unions are generally in favour of the energy transition and the new employment it creates. From 2011, the president of the IG BCE, the energy and mining union, which has more than 660,000 members, declared that nuclear power had no future in Germany.
The union's position is more ambiguous on fossil fuels. In 2014, they supported Energy Minister Sigmar Gabriel in opposing a rapid exit from coal, even stating that it would be acceptable for Germany to fail to hit its targets for 2020.

In general, trade unions seek to maintain a balance between opposition to job losses in conventional power generation - a sector in which they are well established - and improved working conditions in the sectors experiencing strong growth such as renewable energies or energy efficiency. At its congress in May 2018, the DGB, the association of German trade unions, which has 6 million members, for example, reiterated its support for the Paris Agreement objectives and called for a «fair Energiewende» that ensures affordable energy for all and creates quality employment.

Sources : Clean energy wire

TEXT BOX 3

Companies involved in the energy transition, from large companies such as Siemens, Enercon or SMA, to cooperatives and Stadtwerke (municipal boards), innumerable SMEs and startups, contribute to the definition of the country's political approach, through associations such as the Bundesverband Erneuerbare Energien (German Renewable Energy Federation), Agentur für Erneuerbare Energien (Renewable Energy Agency) or the wind (BWE), solar (BSW) and biomass (BBE) energy unions.

Siemens, a successful transition at company level

Founded in 1847, Siemens is one of Germany's leading energy companies. In the 1970s and 1980s, Siemens was a major player in nuclear construction in Germany and a regular target of opponents of atomic power. The company permanently withdrew from nuclear construction in 2011 in the aftermath of the Fukushima disaster and turned resolutely towards green technologies.

Siemens undertook a reorganisation to take advantage of the development of these activities by breaking away from some of its historical branches, such as railways or lighting. At the end of 2017, the company cut 6,900 jobs in its gas and electricity division. The same year it merged its wind division with its competitor Gamesa to form a global wind turbine manufacturer. Siemens is also active in smart grids, electric vehicles, energy efficiency, etc. The proceeds of this «environmental portfolio» represent half of its revenues and the company estimates that they led to reductions in greenhouse gas emissions by 570 million tonnes in 2017, the equivalent of 70% of German emissions. The company has set up a dedicated start-up development division (Next47) and is now developing innovative projects for the further development of renewable energies in Germany, such as the Wildpoldsried renewable micro-grid. This does not mean that Siemens cannot take part in debates on the German energy transition, which its CEO considers «good on principle but poorly managed» (open letter to Martin Schulz, 22 November 2017). For example, the company has informally contributed to discussions by the ecologist party, Die Grünen (the Greens), on exiting from coal, and in early 2018 it offered to help the Lusatian mining region convert to electric mobility.

In 2016, Siemens joined the Carbon Pricing Leadership Coalition, the World Bank's carbon price initiative. In 2017, the Corporate Knights organisation recognised Siemens as the most sustainable world company, particularly for its commitment to renewable energy and its own energy performance. Siemens wishes to achieve carbon neutrality in 2030 and is the first global industrial group to have made this commitment.

Source : Siemens

TEXT BOX 4

Not all energy companies have benefitted from the German energy transition. Since the 1990s, the four main electricity producers (RWE, Eon, EnBWE and Vattenfall) have expressed their opposition to the development of renewables in the press and courts. However, this has not prevented

the German government from involving them in the decisions. In particular, the exit from nuclear power was negotiated with these four companies and the agreement specified the amount of electricity that could be produced by each reactor before its closure to enable them to plan and adapt. Be that as it may, the adoption of the Energiewende in 2011 led to a period of crisis for the major German power companies, resulting in multiple reorganisations (Kungl, 2018).

Finally, the government has sought to maintain the competitiveness of the manufacturing industry, which accounts for almost a quarter of the country's production. For both the majority of the political class and the powerful German professional organisations, maintaining German industrial competitiveness is seen as one of the keys to the success of the energy transition. Energy-intensive industries are generally exempted from the additional costs associated with the energy transition and, conversely, benefit from the fall in the wholesale price of electricity.

4 • NEW CHALLENGES

Despite its progress, the German energy transition is not complete. Germany faces new challenges if it wants to continue reducing its emissions through renewables and to become a benchmark.

• TOWARDS THE END OF COAL • Despite dropping sharply in the electricity mix, the residual share of coal and, in particular, of lignite, which emits more carbon dioxide, makes the German electricity mix one of the main sources of emissions in Europe. A coal exit project, similar to the nuclear exit project adopted in 2000, is essential if Germany is to meet its emissions targets after 2020 and maintain its credibility in the fight against climate change.

The country is trying to replicate the successful method of the 2000s, but the political consensus that has driven the transition until today no longer exists, mainly due the economic and social importance of coal in the disadvantaged Länder of the East.

Building consensus on the exit from coal

A commission on exiting coal was set up by the government on 6 June 2018. It has to make proposals to the coal regions in October and make recommendations in December so that Germany can move closer to its emissions targets for 2020. Its final report is expected by the end of the year; it must contain a roadmap for the exit from coal and set the date for the closure of the last plant.

The commission has 4 co-chairs, 8 ministry representatives, 6 representatives of coal regions, 3 members of parliament and 24 qualified individuals. Its membership reflects the search for the widest possible consensus. Länder coal producers will play an important role: in addition to the 6 regions represented (North Rhine-Westphalia, Saxony, Brandenburg, Saxony-Anhalt, Lower Saxony and Saarland), former leaders of Brandenburg and Saxony are among the four co-chairs and representatives of local coal-dependent local authorities are among the qualified individuals, such as the president of the association of mayors of Lusatia, another coal-mining region.

The qualified individuals are from the business world (companies, trade unions and business associations) and the academic world (one of the co-chairs is a former leader of Agoraenergiewende). An important place is also reserved for NGOs (such as Greenpeace and Friends of the Earth) and for local citizen movements.

Sources : www.cleanenergywire.org/factsheets/germanys-coal-exit-comission

TEXT BOX 5

• THE PROBLEM OF CHANGING THE SCALE OF ENERGY DECENTRALISATION • Decentralised initiatives have played an important role in the German energy transition - indeed, they are among its most notable aspects. But progress in these modes of energy production and distribution must also accept a growing role in running the network and in the electricity market, so a tighter framework will become necessary (Beermann, 2017).

In order to reduce the cost of renewable energy development, the 2017 Renewable Energy Law replaced the old feed-in tariff guaranteed by an auction mechanism. This complex and competitive system has a high failure rate that sometimes discourages projects led by non-professionals: preliminary data suggest that the number of citizen projects has dropped by 25% (Trend Research, 2017). The 2017 law also made the definition of citizen projects more flexible, which seems to have enabled some developers to obtain this label.

The reform of the renewable energy support mechanisms and the growing institutionalisation of production could therefore encourage large groups to the detriment of citizen projects, which will stop one of the main drivers of the German transition.

CONCLUSION

It is now very likely that Germany will complete the replacement of all its nuclear production by renewable energies in 2022, thus completing a transformation of its electricity mix that was planned at the end of the 1990s. But this success is but a first step: to honour its climate commitments, Germany must now commit to exiting from coal. If it manages to do this, it will show that its method is replicable, thus reinforcing its ambitious energy policy model based on consensus and leaving a large space for civil society.

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