

THE ENERGIEWENDE AND GERMANY'S INDUSTRIAL POLICY

DAAN RUTTEN



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TABLE OF CONTENTS

EXECUTIVE SUMMARY	9
1 INTRODUCTION	11
2 THE ENERGIEWENDE TO DATE	13
3 INDUSTRIELAND DEUTSCHLAND	17
3.1 Challenges	18
3.2 The opportunity of low-cost electricity	22
3.3 A greening industry	26
4 A GERMAN TRADITION	29
4.1 The German coal industry	30
4.2 The rise of nuclear energy	32
4.3 A new, green millennium	33
LIST OF ABBREVIATIONS	35
APPENDIX	37

EXECUTIVE SUMMARY

To understand the drivers behind the German *Energiewende*, it is helpful to view this energy transition from the perspective of Germany's industrial interests. Government policies give preferential treatment to certain segments of the country's industrial sector, while shielding other segments either fully or partially from the transition's unfavourable consequences. A strong connection between Germany's industrial and energy policy is nothing new. Historically, the German government has actively supported coal and nuclear energy in its electricity mix due to their domestic availability and the strong position of German industry in the nuclear business. These past experiences suggest that current developments are part of a German tradition of approaching industrial and energy policy as a unit. Therefore, when analysing past, current and possible future developments of the *Energiewende*, it is important to keep Germany's various industrial interests in mind.

Current developments show that the *Energiewende* is focussing mainly on the large-scale deployment of renewables, while reducing Greenhouse Gas (GHG) emissions and energy consumption appears to be of less importance for now. This has created several challenges that directly affect the German industrial sector. The geographical distance between renewable electricity generation and industrial centres is a practical concern. The lack of sufficient infrastructure to connect the wind-rich north with the energy-hungry industrial south poses potentially severe constraints on future developments of the *Energiewende*. The second and most voiced friction point is the cost. Taxes associated with the energy transition account for an increasing share of Germany's electricity prices, both for households and for industry. This is closely related to a third challenge, namely the unequal distribution of these costs for electricity consumers. Energy-intensive companies can receive exemptions from these taxes, shielding them from increasing costs. As a consequence, other electricity consumers must pay a higher levy because total costs need to be covered. This creates tensions between households and industry, between the different parts of the industrial sector itself, and beyond Germany's borders.

Challenges aside, the *Energiewende* has benefitted German industry in many ways. As a result of the merit order effect, energy-intensive companies eligible for exemptions profit from lower wholesale electricity prices. Germany's highly integrated supply chains and industrial clusters mean that its industrial sector as a whole benefits from

this. The backbone of the German economy, the *Mittelstand* (small- and medium-sized enterprises), however, is mostly excluded from these exemptions. Yet the fact that the country's international competitiveness is largely based on quality rather than price differences, stemming from being a country which traditionally has had a hard currency, means that an increase in production costs does not necessarily lead to a loss in competitiveness. Furthermore, the increased demand for renewables, created by the Energiewende, has resulted in the establishment of a German green industry. This is now among the most advanced in the world, owing significantly to Germany's domestic policies which have stimulated investments in new, green technologies as well as to the country's strong manufacturing industry.

These challenges and opportunities are in line with the German tradition of approaching industrial and energy policy as a unit. This paper advocates that Germany's industrial interests are therefore a useful lens through which past, current and possible future developments of the Energiewende should be analysed.

1 INTRODUCTION

The Energiewende is bringing about fundamental changes to Germany's energy mix through short-, medium-, and long term targets.¹ Yet despite numerous studies, there is still a lack of clarity about the forces behind the Energiewende. Reports of these drivers vary considerably, touching upon affordability, import dependency and environmental concerns, as well as ethical issues. This paper argues that they all play a role but that the Energiewende cannot be understood properly without placing it in the context of Germany's industrial policy.

In Germany, industrial and energy policy are approached as a unit. In the past, German governments have actively intervened in the country's energy mix, showing strong preferences for fuels which were domestically available and/or technologically interesting for German industry. The country's most recent energy transition, the Energiewende, should be placed in that context. Rather than viewing the German industry as a single coherent actor, emphasis should be placed on its diversity, which manifests in diverging interests and energy demands. In that respect the Energiewende affects the German industrial sector in differing ways, depending on which part is under the microscope.

A widely debated topic both nationally and internationally, the Energiewende has recently received widespread criticism questioning its economic soundness. Rising energy costs are said to be eating away at Germany's industrial competitiveness, jeopardising the very motor of the German economy, the Mittelstand, as well as its world-famous automobile industry. Important energy-intensive sectors claiming to be affected include aluminium and steel producers and the petrochemical industry.² Nonetheless, this paper argues that the Energiewende should in fact be seen as part of German industrial policy.

To obtain a better understanding of the drivers behind the Energiewende, this paper will first turn to the current state of affairs. Some of the Energiewende's targets show more headway than others, revealing its current priorities. Next, attention will be paid

1 Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (2011), 'Das Energiekonzept der Bundesregierung 2010 und die Energiewende 2011'.

2 See, for example, public statements by various industry organisations: the Bundesverband der Deutschen Industrie, Energieintensive Industrien in Deutschland, and the Bundesverband der Energie- und Wasserwirtschaft.

to the German industrial sector and its prominent role in the country's economy. The Energiewende's effects on the different industries will be highlighted, emphasising the diversity of Germany's industrial base. This will show that some sectors are affected negatively, while others experience positive effects. Finally, to better understand the present and future, a look at the past will reveal that this is not the first time that parts of the German industrial sector have received preferential treatment when the country is faced with an energy transition. Current developments can therefore be seen as part of a German tradition of approaching industrial and energy policy as a unit.

2 THE ENERGIEWENDE TO DATE

In order to assess the implications of the Energiewende for German industry up to now, it is necessary to first look at the developments of this energy transition. The Energiewende encompasses various short- and medium-term targets aimed at allowing Germany to achieve a set of ambitious goals by 2050. The German government announced the transition in 2010 in its *Energiekonzept*.³ In this study, the focus is on the four 2020 goals that are most clearly defined and which apply to the energy system as a whole:⁴

- a 20% reduction in energy consumption compared to 2008 levels,
- a 40% reduction of GHG emissions compared to 1990 levels,
- an 18% share of renewables in the energy mix, and
- a 35% share of renewables in the electricity mix.

In addition to the Energiewende's goals, the future of the German energy sector is also determined by the *Atomausstieg* of 2011, which calls for the complete phase-out of nuclear power by 2022. Although this decision was already enacted in 2002 under the red-green coalition of Schröder, nuclear power plants received a 12-year life extension in 2010 to serve as a 'bridge technology' towards a renewable future.⁵ At the turn of the millennium, nuclear energy represented approximately 30% of total electricity generated in Germany, and by 2010 it still generated 22%.⁶ However, the Fukushima disaster of 2011 caused great commotion in Germany and led Merkel to recall the decision to prolong nuclear power, thereby complicating the Energiewende package as a whole.

Between 2008 and 2013 German energy consumption dropped by only 3.3%, well short of the trajectory necessary to reach the 2020 goal of 20%, as can be observed in Figure 1, below.

3 Bundesministerium für Wirtschaft und Technologie (2012), 'Die Energiewende in Deutschland'.

4 For a full account of the goals of the Energiewende, as well as the progress up to 2012, please see Table 1 in the Appendix.

5 Der Spiegel (2011), 'Phasing in the Phase Out: Germany Reconsiders Reactor Lifespan Extensions'.

6 Bundesministerium für Wirtschaft und Energie (AGEE-Stat) (2014).

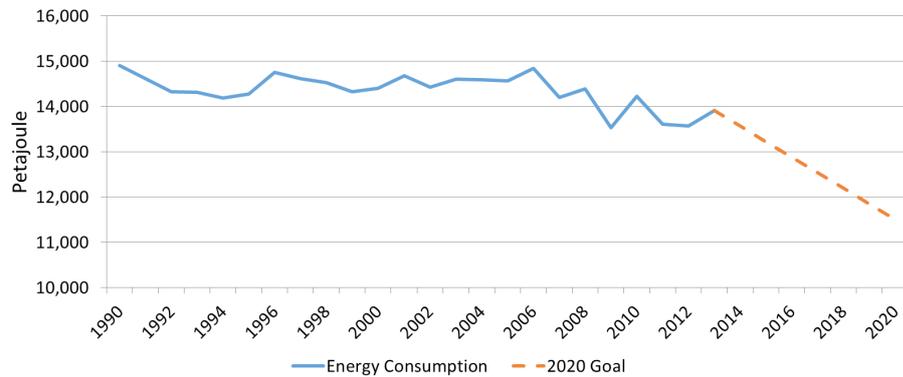


FIGURE 1. ENERGY CONSUMPTION IN GERMANY 1990-2013. THE DOTTED LINE INDICATES THE LINEAR RATE OF REDUCTION NECESSARY TO REACH THE 2020 GOAL.⁷

It is important to note that this time frame includes the financial crisis, clearly visible in the 2009 drop in energy consumption, as well as the period of low economic growth since then. Looking back to 1990 shows that energy consumption has steadily declined, but energy efficiency improvements will need to be accelerated in order to reach the 2020 goal of a 20% reduction. From 1990 to 2013, the average annual decline rate was 0.30%. Though this number increased to 0.73% between 2010 and 2013, a staggering annual reduction of 2.67% will be necessary in the coming seven years in order to reach the 2020 goal.⁸

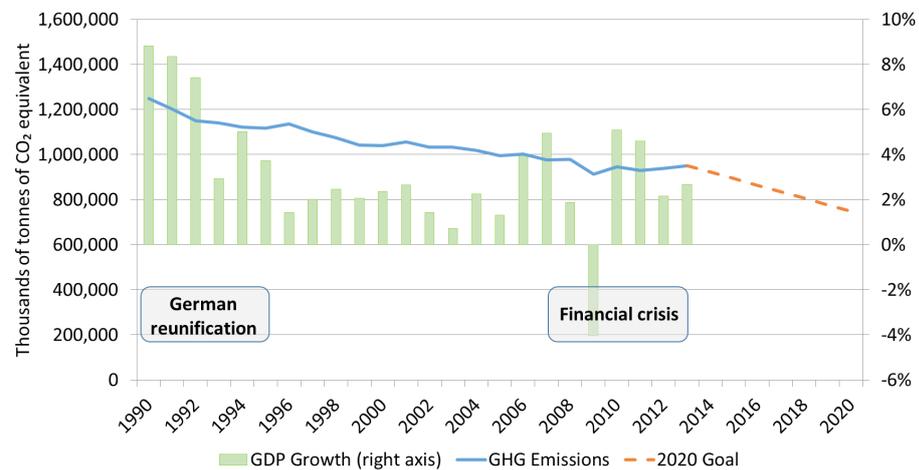


FIGURE 2. GDP GROWTH AND GHG EMISSIONS GERMANY, 1990-2013. THE DOTTED LINE INDICATES THE LINEAR RATE OF REDUCTION NECESSARY TO REACH THE 2020 GOAL.⁹

7 Data retrieved from Bundesministerium für Wirtschaft und Energie (AGEE-Stat) (2014).

8 CIEP calculation using the compound annual growth rate formula. Data retrieved from Bundesministerium für Wirtschaft und Energie (AGEE-Stat) (2014).

9 GHG data from 1990-2012 retrieved from EEA (2014), and the 2013 estimate from Umweltbundesamt (2014). Data for GDP growth is adjusted for inflation and retrieved from Eurostat (2014).

The same applies for the second goal, the reduction of GHG emissions, as can be observed in Figure 2. So far, Germany's trajectory has fallen short of that needed to meet the 2020 target, despite a rather consistent decline since the base year of 1990. However, the period since then also includes the aforementioned financial crisis as well as German reunification in 1990. The latter led to a large restructuring of the East German economy, including the closure of old, large, GHG-emitting, coal-fired power plants.¹⁰ This can be observed in the steeper decline in GHG emissions during the period 1990-1995. The 1990s therefore accounted for 70% of the total decline in GHG emissions up to 2013, whereas 2012 and 2013 actually witnessed an increase. This can be attributed to the rising consumption of coal in electricity generation.¹¹ By 2013, German GHG emissions reduction stood at 23.8% of 1990 levels.¹² In order to meet its 2020 goal of a 40% reduction in GHGs, Germany will need to considerably pick up the pace between now and 2020, as can be observed by the line in Figure 2. The average annual decline rate will have to rise to 3.34% from 2013 until 2020, compared to an average of 1.18% between 1990 and 2013.¹³

The outlook is more positive when it comes to the share of renewables in the energy and the electricity mix. As for the former, in 2013 it accounted for 12.3%, and in 2012 this figure was the same. The overall positive trajectory towards the 2020 target of 18% means that Germany is on track. This is depicted in Figure 3. The share of renewables in the electricity mix rose to 25.4% in 2013, well ahead of schedule for the 2020 target of 35%.¹⁴ Figure 3 clearly shows the sharp increase since the start of the Energiewende in 2010. The fact that this has not yet translated into significant GHG emission reductions can be attributed to the fact that renewables are replacing decommissioned nuclear- and gas power plants rather than coal-fired ones.¹⁵

10 Fraunhofer Institute for Systems and Innovation Research et al. (2001), 'Greenhouse Gas Reductions in Germany and the UK – Coincidence or Policy Induced? An analysis for international climate policy'.

11 A. Jungjohann and C. Morris (2014), 'The German Coal Conundrum: The status of coal power in Germany's energy transition'.

12 Important to keep in mind here is the fact that Germany's domestic goal is a 40% reduction of GHG emissions by 2020. This compares to Germany's Kyoto reduction target of 21% for 2012 and the EU's 2020 Strategy of a 20% reduction by 2020. With a 23.8% reduction by 2013, Germany is fulfilling (Kyoto), or at least on track for (EU 2020), its international commitments.

13 CIEP calculation using the compound annual growth rate formula. Data retrieved from Bundesministerium für Wirtschaft und Energie (AGEE-Stat) (2014).

14 Two different numbers are used when discussing Germany's share of renewables in its electricity mix. One (25.4%) refers to electricity consumption in Germany, while the other (23.9%) refers to electricity generation. The difference is caused by exports, which the former number assumes are from non-renewable sources. Because the German government uses the 25.4% for tracking its progress of the Energiewende, this study will do the same.

15 Responding to Climate Change (RTCC) (2014), 'Germany's Carbon Targets in Doubt as Emissions Rise in 2013'.

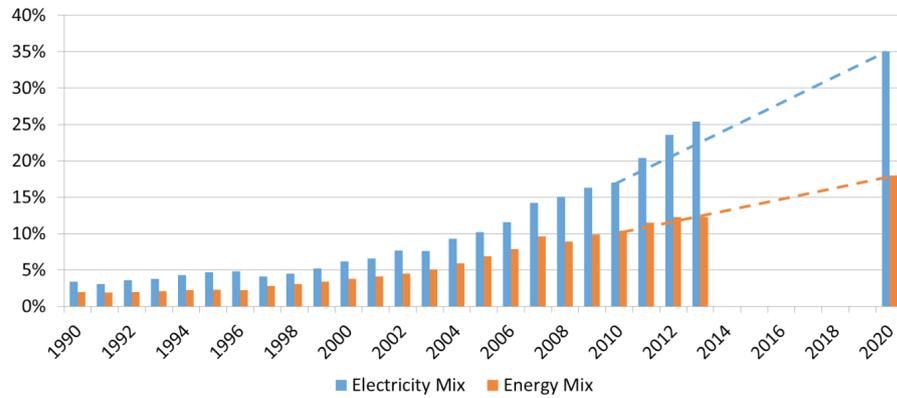


FIGURE 3. RELATIVE SHARE OF RENEWABLES IN GERMANY’S ELECTRICITY AND ENERGY MIX, 1990-2013, AS WELL AS THE 2020 ENERGIEWENDE GOALS OF 35% AND 18%. THE DOTTED LINES START AT 2010, THE YEAR THE GOALS WERE SET IN THE ENERGIEKONZEPT.¹⁶

Germany, therefore, appears for now to be more focussed on the deployment of renewables throughout the country than on the reduction of GHG emissions and energy consumption.¹⁷

16 Data retrieved from Bundesministerium für Wirtschaft und Energie (AGEE-Stat) (2014).

17 Planbureau voor de Leefomgeving (PBL) (2013), ‘De Duitse Energiewende: Inspiratie voor Nederland?’

3 INDUSTRIELAND DEUTSCHLAND

The importance of the German economy to Europe can hardly be exaggerated. It is the largest economy in the European Union (EU) and the fourth worldwide in Gross Domestic Product (GDP).¹⁸ The manufacturing industry is an important part of the German economy, representing 30.5% of its GDP.¹⁹ This is a high number compared to other major economies, and the Ministry of Economics and Energy therefore adequately describes the country as *Industrieland Deutschland*.²⁰ The German industrial sector focuses heavily on exports and accounted for 7.7% of world exports in 2013, placing it third in the world.²¹

Internationally German industry excels in the production of cars, machines and chemicals and in electrotechnology.²² Many of the basic goods used in the production cycles of these industries, such as aluminium, steel and glass, are produced in Germany itself and stimulate the German economy as a whole.²³ These are energy-intensive industries and, compared to in other Organisation for Economic Co-operation and Development economies, they represent a relatively large share of the German economy.²⁴ The energy bill, therefore, is an important factor for the competitiveness of the country's industrial sector and the German economy as a whole.²⁵ Within Germany's highly integrated supply chains and industry clusters, energy-intensive and non-energy-intensive businesses are intricately connected, providing German industry with a competitive advantage internationally as well as guaranteeing high-quality products. These characteristics make the Energiewende a very relevant development for the country's entire industrial sector, creating both challenges and opportunities.²⁶

18 The World Bank (2014).

19 CIA (2014), 'The World Factbook'. These numbers for other countries are as of 2013: United States (19.2%), United Kingdom (20.8%), France (24.3%) and The Netherlands (25.4%). The EU-average is 25.2%.

20 Bundesministerium für Wirtschaft und Energie (2014).

21 Ibidem. China occupies the first place with a global share of 11.8%, followed by the USA with 8.4%. The Netherlands is the next highest ranking European country after Germany, with 3.5%, thereby occupying fifth place. France stands at 3.1% (6th) and the United Kingdom at 2.9% (8th). These numbers exclude intra-EU trade.

22 Bundesministerium für Wirtschaft und Energie (2014).

23 Energieintensive Industrien in Deutschland (2014), 'Steigende Energiekosten bedrohen die industrielle Wertschöpfungskette in Deutschland'.

24 Organisation for Economic Co-operation and Development (OECD) (2012), 'OECD Economic Surveys: Germany 2012'. The energy-intensive industrial sector represented around 9% of total value-added in 2009 in Germany, compared to a 6.5% OECD Europe average. The USA, the Netherlands, the United Kingdom and France, in that order, all hovered around 6%.

25 Information Handling Services (IHS) (2013), 'The Challenge to Germany's Global Competitiveness in a New Energy World'.

26 Information Handling Services (IHS) (2014), 'A More Competitive Energiewende: Securing Germany's Global Competitiveness in a New Energy World'.

3.1 CHALLENGES

As shown, the most visible effect of the Energiewende to date has been the deployment of renewables throughout Germany, with installed capacity increasing by 50%, from 56 GW to 84 GW over the past three years.²⁷ This has created several challenges in the implementation of the energy transition, three of which will be examined here, as they are directly related to Germany's industrial sector. The first and most practical one relates to the geographical distance between renewable electricity generation and industrial centres. The second and most commonly voiced friction point is the high costs of the Energiewende. Closely related to this is the third and final challenge, the distribution of these high costs.

Germany's industry is strongly centred in the south of the country, spread out over the *Bundesländern* Baden-Württemberg and Bayern. Around 29% of the German population lives there, and together these two states make up nearly 30% of total power consumption in Germany. Industry represents around 55% and 60% of power consumption in Bayern and Baden-Württemberg, respectively. The chemical and pharmaceutical sectors have a large presence in Bavaria, whereas the automotive sector is mainly located in Baden-Württemberg.²⁸ Nuclear power has traditionally been, and still is, an important source of electricity generation in the south. Of the nine nuclear reactors still operational in Germany, six are located in these two southern states. Their combined electricity generation satisfies around 40% of total electricity consumption in the two states.²⁹ The Atomausstieg, therefore, has major security of supply consequences for Germany's industrial centre. Replacing this generation capacity with renewables is deemed problematic for several reasons.

In 2013 wind power generated the largest share of renewable electricity in Germany (35%), while photovoltaics (PV) stood at 20%.³⁰ Meteorologically speaking, Germany's south is best suited for PV, even if its average amount of sunlight per year is still only comparable to that of Alaska.³¹ The country's wind potential is significantly higher, with the northwest being best suitable for the deployment of windmills, both onshore and offshore in the shallow North Sea.³² Therefore, the bulk of electricity generated by renewables in Germany now, and possibly in the future, is not situated near the country's industrial centre. The appropriate infrastructure to connect the

27 Bundesministerium für Wirtschaft und Energie (AGEE-Stat) (2014).

28 Agora Energiewende (2013), 'Load Management as a Way of Covering Peak Demand in Southern Germany' and Statistische Ämter des Bundes und der Länder (2014).

29 Ibidem and European Nuclear Society (2014), 'Nuclear Power Plants in Germany'.

30 AG Energiebilanzen e.V. (2014).

31 The Washington Post (2013), 'Germany Has Five Times as Much Solar Power as the U.S. – Despite Alaska Levels of Sun'.

32 Agora Energiewende (2013), 'Cost-Optimal Expansion of Renewables in Germany'.

wind-rich north with the industrial south does not yet exist. A major new high-voltage power line is planned to solve this, but it has run into problems due to popular protests relating to health concerns and dropping property values in the north of Bayern. Financing the extension of the German transmission grid is also very costly, adding further delays to an already lagging process. Without this power highway, though, it will be difficult to compensate for the future shutdown of the remaining nuclear reactors in the south.³³ Apart from investments in the transmission grid, more work on Germany's distribution grid are also needed, and this involves many small distribution system operators. The distribution grid has gained in importance in recent years as a result of the increased amount of low-voltage electricity generated by solar PV connected to this grid. Infrastructural bottlenecks, therefore, severely constrain possible future developments of the *Energiewende*.³⁴

Practical concerns aside, the second and recently the most voiced concern of the *Energiewende* is the cost it entails. To support the introduction of renewables, Germany has issued a national Renewable Energy Act called the *Erneuerbare Energien Gesetz* (EEG).³⁵ To cover the costs associated with the EEG, electricity consumers have to pay a fee called the *EEG-Umlage*. As can be observed in Figure 4, the EEG-Umlage currently stands at 6.24 euro cents/kWh, which is more than 20% of the total retail price of electricity for a 3-person household.³⁶ The payments for 2014 are estimated at nearly 22 billion euros.

The EEG gives renewable energy sources preferential access to the electricity grid and fixes their price for a duration of 20 years. Currently allocated renewable capacity costs has been estimated at €185 billion, with every newly installed renewable electricity source adding to this number.³⁷ Despite uncertainty about the exact numbers, what stands out is the fact that it involves large sums of money.

33 The Guardian (2014), 'North-South Divide Threatens Germany's Renewable Energy Highway'.

34 Buchan, D. (2012), 'The *Energiewende* – Germany's Gamble'.

35 For a brief overview of the history of the EEG, please see Box 1 in the Appendix.

36 Bundesverband der Energie- und Wasserwirtschaft (BDEW) (2014), 'BDEW-Strompreisanalyse Juni 2014. Haushalte und Industrie' and 'Europäischer Strompreisvergleich'. As a comparison, during the first half of 2013 the electricity price, including taxes, for a German household (2500-5000 kWh/year) was €0.2919/kWh, the second highest in Europe after Denmark. This is considerably higher than in the Netherlands (€0.1955), the UK (€0.1741), France (€0.1472) and the EU (28) average of €0.2002.

37 Information Handling Services (IHS) (2013), 'The Challenge to Germany's Global Competitiveness in a New Energy World'.

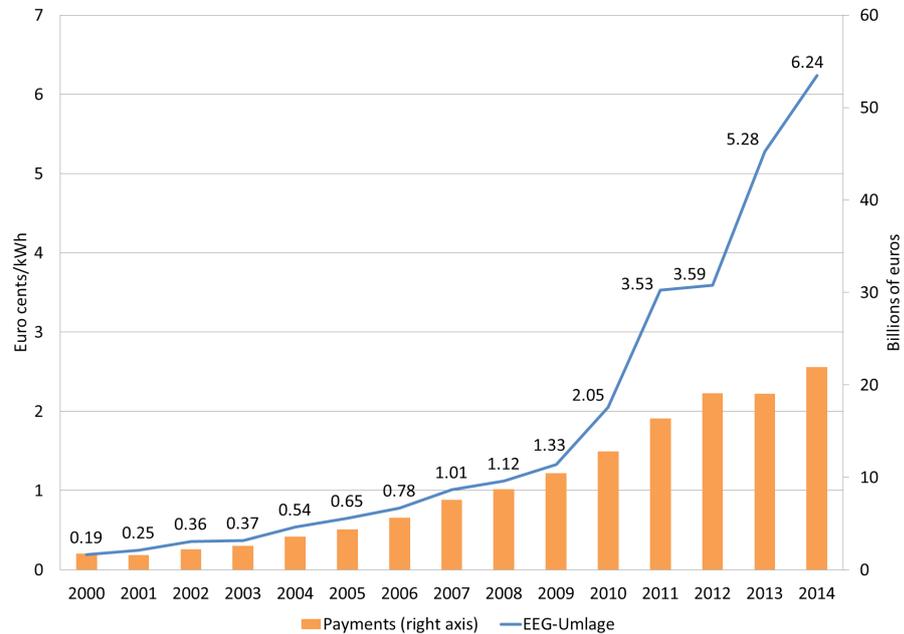


FIGURE 4. DEVELOPMENTS OF THE EEG-UMLAGE AND THE EEG PAYMENTS FROM 2000-2014.³⁸

Important for these high costs is the failure of the EEG to react to changes in technology costs. This is most visible with solar PV technology, as the cost for a PV module dropped significantly between 2010 and 2012. The fact that high feed-in tariffs were maintained led to a surge in installed PV capacity, 23 GW within three years, thereby significantly increasing the total costs of the EEG.³⁹ To prevent this from occurring in the future, the new German government introduced changes to the EEG in 2014 by introducing so-called ‘extension corridors’. They serve to limit the overall costs of the EEG by setting specific capacity extensions limits for each renewable technology.⁴⁰ The previous inflexibility to react to changes in technology costs caused electricity prices for the German industry to increase as well, with taxes and other policy costs accounting for as much as 30% of total costs in 2012, placing Germany’s international competitiveness at risk.⁴¹

38 Fraunhofer Institut für Solare Energiesysteme (ISE) (2014), ‘Kurzstudie zur Historischen Entwicklung der EEG-Umlage’. The 2014 payments number is an estimate.

39 Fraunhofer Institute for Solar Energy Systems (ISE) (2013), ‘Recent Facts About Photovoltaics in Germany’. For comparison, the worldwide increase in installed PV capacity in those three years totalled 61 GW. See: European Photovoltaic Industry Association (EPIA) (2014), ‘Global Market Outlook for Photovoltaics 2014-2018’.

40 Bundesministerium für Wirtschaft und Energie (2014), ‘EEG-Reform: Planbar. Bezahlbar. Effizient’.

41 Ibidem. The range for end consumers with a consumption of 70-150 GWh/year was between 23% and 30%. This was as low as 3% in the UK and 9% in France.

When talking about costs, an important question is who pays for it. This holds true for Germany as well, as costs are not equally distributed over the country's electricity consumers: the third challenge for the Energiewende. For households, this is related to a redistribution of wealth within Germany, which could lead to a decrease in public support for the energy transition. It is generally the more affluent who are able to purchase solar panels and thereby reduce their electricity bill, while the less fortunate pay an ever-increasing EEG-Umlage for their electricity consumption; effectively this is redistributing wealth from the poor to the rich.⁴² More and more Germans are now experiencing *Energiearmut*, or energy poverty, which means they spend more than 10% of their income on energy bills.⁴³ As a result of a stronger rise in electricity prices relative to wages, the share of German households in energy poverty rose from 13.8% to 17% between 2008 and 2011, an increase of 1.4 million households.⁴⁴ A rise in power cuts has also been observed by German power providers.⁴⁵ Although support for the Energiewende remains high, respondents considering the energy transition the 'right thing to do' declined from 63% to 56% between 2011 and 2013. A noticeable income gap exists here as well, with households having a higher income being more likely to advocate their support than ones with a lower income.⁴⁶

This redistribution of wealth is not only taking place between households; there is also a transfer of wealth between them and German industry, as well as within the industrial sector itself, this again being a reflection of the sector's diversity. Energy-intensive users, which represent an important part of the German manufacturing industry, can receive partial exemptions from the EEG-Umlage, depending on their annual electricity consumption and the share of energy in their overall costs.⁴⁷ This is done so that they can maintain their international competitiveness.⁴⁸ As a consequence, all other consumers pay a higher premium, since total costs still need to be covered. This has sparked protests not only from within Germany, but also from abroad. Last year the European Commission (EC) opened an inquiry into the industrial exemptions of the EEG 2012 to see whether they constitute illegal state aid.⁴⁹ Without these exemptions the German industrial sector fears that it would lose international competitiveness due to high energy bills. This issue affects Germany's position not

42 Der Spiegel (2013), 'Germany's Energy Poverty: How Electricity Became a Luxury Good'.

43 Der Spiegel (2014), 'Energiearmut: Im dunklen Deutschland'.

44 Der Spiegel (2014), 'Energiearmut in Deutschland nimmt drastisch zu'.

45 Renewables International (2014), '175,000 German Households Had Power Cut Off'.

46 Renewables International (2014), 'Popular Support for Energiewende Waning'.

47 Der Spiegel (2012), 'Medium Sized German Companies Criticize Energy Tax Breaks for Industry'.

48 Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (2012), 'Gesetz für den Vorrang Erneuerbarer Energien'.

49 European Commission (2013), 'State Aid: Commission opens in-depth inquiry into support for energy-intensive companies benefitting from a reduced renewables surcharge'.

only in Europe but also worldwide, especially now that the US is experiencing lower energy prices as a result of its shale revolution.⁵⁰

Challenges aside, the political support for the large-scale introduction of renewables in Germany's electricity mix has produced several positive spin-off effects for German industry and the German economy as a whole, some of which are already present and others which might materialise in the future. This paper focuses on two of them, the first being lower wholesale electricity prices. Important for this are the aforementioned EEG exemptions, which shield parts of the industry from costs related to the Energiewende, while others benefit from lower energy prices. The second spin-off effect is the creation of a so-called 'green industry' in Germany.

3.2 THE OPPORTUNITY OF LOW-COST ELECTRICITY

The most visible effect of the Energiewende, namely the large-scale introduction of renewables in Germany's electricity mix, has simultaneously resulted in a reduction of electricity wholesale prices and a rise in consumer electricity prices.⁵¹ The latter is a result of the aforementioned EEG-Umlage. Whether this is a positive or negative development depends on which industrial sector is under the microscope. Government policy plays a vital role in this through the allocation of EEG exemptions. As noted earlier, taxes and other policy costs increasingly account for a higher share of German electricity prices.⁵²

Energy-intensive industries have the highest potential to experience negative effects from a rise in energy prices and are largely exempted from the EEG-Umlage; they therefore do not carry the costs associated with stimulating renewables.⁵³ Sectors which are considered energy-intensive industries are manufacturers of paper and paper products, chemicals and chemical products, pharmaceuticals, non-metallic minerals, iron and steel, and non-ferrous metals.⁵⁴ For Germany, this includes companies such as chemical company BASF, aluminium producer Trimet and technology company Thyssen Krupp.⁵⁵ Overall, the 2014 changes to the EEG mean that the exemptions regime will remain largely in place, thereby sheltering Germany's energy-intensive industries from the country's energy policy.

50 Zachmann, G. and Cipollone, V. (2013) 'Energy Competitiveness' in Veugelers, R. (Ed.) (2013), *Manufacturing Europe's Future*.

51 Eurostat (2014).

52 Ibidem. The range for end consumers with a consumption of 70-150 GWh/year was between 23% and 30%. This was as low as 3% in the UK and 9% in France.

53 Der Spiegel (2012), 'Medium Sized German Companies Criticize Energy Tax Breaks for Industry'.

54 European Commission (2014), 'Energy Prices and Costs Report'.

55 Bundesamt für Wirtschaft und Ausfuhrkontrolle (2014), 'Unternehmen bzw. Unternehmensteile, die im Jahr 2014 an den aufgelisteten Abnahmestellen von der Besonderen Ausgleichregelung profitieren'. See Box 2 in the Appendix for a brief analysis of the EEG exemptions and its requirements.

On 9 April 2014, one day after the German government announced the EEG 2014 reforms, the EC published new guidelines on public support for environmental protection and energy, which were, not surprisingly, in line with each other.⁵⁶ Moreover, due to the increased share of renewables in the electricity mix, wholesale electricity prices have actually decreased in Germany as a result of the merit order effect, making electricity cheaper for these exempted consumers.^{57, 58} This is shown in Figure 5. Since the start of the Energiewende, wholesale electricity prices have been consistently decreasing in Germany, while countries such as France and the United Kingdom have witnessed increases. The vast majority of German industry, however, does not qualify for exemptions and therefore pays a higher price for its electricity. This includes the motor of German economy: the Mittelstand.

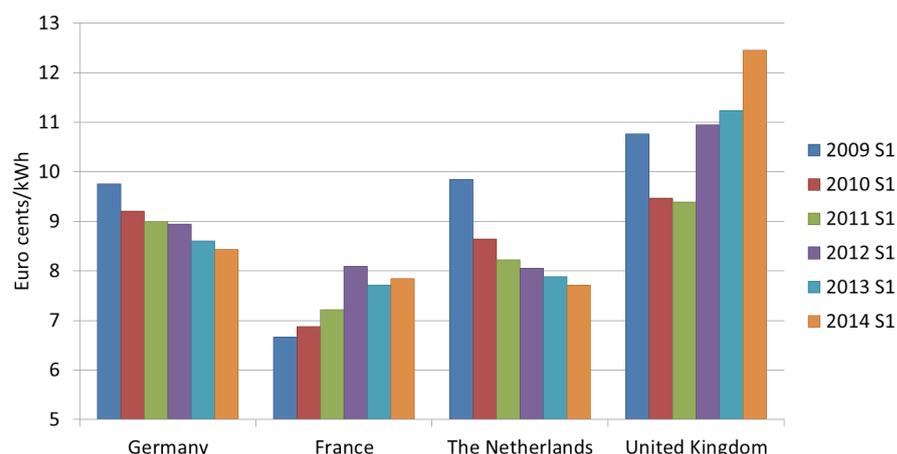


FIGURE 5. ELECTRICITY PRICES EXCLUDING TAXES AND LEVIES FOR INDUSTRIAL CONSUMERS WITH AN ANNUAL CONSUMPTION BETWEEN 500 MWH AND 2000 MWH.⁵⁹

Germany's economy stands out from others due to its large share of small- and medium-sized enterprises which, according to European definitions, are firms with a maximum of 250 employees and 50 million euros of annual revenue.⁶⁰ This section of the German economy is known as the Mittelstand and encompasses more than

56 Bundesministerium für Wirtschaft und Energie (2014) and European Commission (2014).

57 The Economist (2013), 'How to Lose Half a Trillion Euros', and Energiewirtschaftliches Institut an der Universität zu Köln (EWI) (2012), 'Analyse der Stromkostenbelastung der energieintensiven Industrie'.

58 Eurostat (2014). As for electricity prices for industrial consumers before taxes, Germany ranked 17th in the EU (28) in the second half of 2013. This is below the average for the EU (28) as well as Euro zone.

59 Eurostat (2014). The decline in Dutch wholesale electricity prices could be explained by the high level of imports of German electricity. The 2009-2013 developments in wholesale electricity prices for other consumption bands are similar to the one portrayed here. A minimal annual consumption of one GWh is necessary in order to be able to qualify for EEG exemptions. For more information on the EEG exemptions, please see Box 2 in the Appendix.

60 Bundesministerium für Wirtschaft und Technologie (2013), 'German Mittelstand: Motor der deutschen Wirtschaft'.

99% of all German enterprises. In 2013 these accounted for 52% of the country's total economic output, 37% of the overall turnover of German companies and 19% of total exports by German firms. The Mittelstand employs approximately 15 million people, or around 60% of all employees subject to social security contributions. Compared to other countries, the German Mittelstand is very active in the industrial sector.⁶¹ However, under the EEG, these companies do not receive exemptions and therefore pay a disproportionate amount to finance the energy transition. This situation may damage Germany's international competitiveness and with that the German economy as a whole.⁶² This unequal distribution of the EEG costs is a divisive factor within Germany.⁶³ The international competitiveness of German industry, however, is not solely based on price.

What characterises German industry overall is its focus on quality rather than price. This is closely related to the country's history of having a strong currency, the *Deutsche Mark*. After World War II, the *Bundesbank's* primary goal was domestic price stability, due to Germans having effectively lost their savings twice as a result of the hyper-inflation of 1923 and another round of inflation in 1945.⁶⁴ In its quest for domestic price stability, the *Bundesbank's* contractionary monetary policy ensured high interest rates and therefore a strong foreign demand for the *Deutsche Mark*, together with increased foreign investments. This was strengthened by Germany's *Wirtschaftswunder* (economic miracle) during the same time period, which, in combination with sound economic policy, created a positive outlook on Germany's overall economic situation. As a result of the strong international position of the *Deutsche Mark*, importing goods into Germany became cheaper, while exporting German goods became relatively more expensive. The German industrial sector has therefore been limited in its ability to use price differences to improve its international competitiveness. This does not mean that production costs have been irrelevant to the German economy, as visible in the cap restraint on German wages over the 25 years since German reunification, leading to an improvement in the country's international competitiveness.⁶⁵ Nonetheless, German industry has focussed on quality. In relation to the *Energiewende* and increased electricity prices, this means that increases in production costs, resulting from higher energy costs, do not necessarily lead to a decrease in demand for German products. This is the result of demand elasticity

61 Ibidem.

62 Bloomberg (2014), 'German Green Energy Push Bears Reluctant Power Suppliers'.

63 Der Spiegel (2012), 'The High Price of Clean Energy: Tax Breaks and Subsidies for Industry Divide Germans'.

64 Hetzel, R.L. (2002), 'German Monetary History in the Second Half of the Twentieth Century: From the *Deutsche Mark* to the Euro'.

65 The New York Times (2014), 'How Underpaid German Workers Helped Cause Europe's Debt Crisis'.

being generally lower in high margin, high value-added markets than in low margin, high volumes markets,⁶⁶ the latter being an example of an economy focussed on price.

The bulk of the German automobile industry, famous worldwide for its quality brands such as Mercedes-Benz, Audi, BMW and Porsche, does not receive exemptions from the EEG-Umlage. Still, it uses many energy-intensive products such as aluminium, thereby effectively profiting from the companies that do receive exemptions. The EEG-Umlage represents over a third of the German automobile industry's electricity bill.⁶⁷ International competitiveness is its main concern regarding the Energiewende, due to the share of sales being larger abroad than domestically.⁶⁸ Despite the high energy prices and the financial crisis, however, the German automobile industry has experienced an increase in export value over the past few years.⁶⁹ BMW sold the most luxury cars worldwide in 2012 and 2013, with Audi and Mercedes-Benz also occupying strong market positions globally.⁷⁰ Because these companies focus on added value rather than price, energy prices above the global average do not necessarily undermine the level of their exports. Their strength in safety and reliability, as well as their luxury status, ensure that a global demand for their products will exist. For such industries, the availability of a skilled workforce, competitive wages, geographical advantages and the presence of other industries to form clusters (such as aluminium producers) further means that they do not move production sites easily.⁷¹

The same applies to the Mittelstand, which is highly innovative and technology-driven, producing mainly specialised products and services to industry rather than well-known everyday goods. Germany boasts a high number of 'hidden champions', companies which rank in the top three of their global market. The German Mittelstand contains around 1300 of them, with a strong focus in machine equipment, electrical engineering and diverse industrial products and services.⁷² Companies producing green technologies are also well represented here, and it is here that Germany's green industrial base can be found.⁷³

66 Baumol, W., and Blinder, A. (2010), 'Economics. Principles & Policy'.

67 Wirtschafts Woche (2013), 'Autoindustrie befürchtet Standortnachteile'.

68 Verband der Automobilindustrie (VDA) (2013), 'Position des VDA zum EEG'.

69 Zachmann, G. and Cipollone, V. (2013) 'Energy competitiveness' in Veugelers, R. (Ed.), *Manufacturing Europe's Future*.

70 The Guardian (2014), 'Carmaker BMW Keeps Luxury Top Spot with Record 2013 Sales'.

71 Zachmann, G. and Cipollone, V. (2013) 'Energy Competitiveness' in Veugelers, R. (Ed.), *Manufacturing Europe's Future*.

72 Bundesministerium für Wirtschaft und Technologie (2013), 'German Mittelstand: Motor der deutschen Wirtschaft'.

73 Bundesministerium für Wirtschaft und Energie (2014), 'Introducing the German Mittelstand'.

3.3 A GREENING INDUSTRY

Germany is considered a global leader in renewable technology and would not have reached this status without its domestic market and government policies.⁷⁴ Characteristic of the German economy is the high percentage of employment in high-technology manufacturing sectors, easily surpassing France, the UK and the Netherlands.⁷⁵ This goes hand in hand with the German government's high budget appropriations on research and development: 2.02% of total government expenses in 2012, having grown consistently over the preceding seven years.⁷⁶ This is also reflected in the large number of patent applications initiated in Germany, accounting for nearly half of all the patent applications of the EU-28 in that same year.⁷⁷ In both solar PV and wind energy, Germany is considered a global leader, although these two energy sources do not share the same performance record.

The German solar industry rose rapidly over the past decade but has now encountered heavy competition from Asia, and China in particular.⁷⁸ This has recently caused an EU-China trade dispute regarding subsidised solar panel exports and alleged dumping practices, resulting in an EU import duty for Chinese solar panels.⁷⁹ Still, most of the PV production has moved out of Germany.⁸⁰ Exceptions are companies such as Manz, which produces thin-film solar cells, a rival of the predominant crystalline silicon solar cell. The majority of German companies currently involved in the PV business are no longer producing modules. Consisting mostly of installers and suppliers, this could indicate a relative shift in focus from manufacturing to services, which can be attributed to the high amount of PV capacity installed in Germany as a result of the EEG.⁸¹ Still, Germany is a world leader in solar PV manufacturing equipment and system-balancing components such as inverters, rather than a major producer of the panels itself.⁸² For Chinese PV manufacturers to be able to assemble PV modules in such large numbers as they have in recent years, they need quality manufacturing equipment. This is in line with the Mittelstand's strength in electrical engineering.

74 International Institute for Sustainable Development (IISD) (2014), 'Germany's Green Industrial Policy. Stable Policies – Turbulent Markets: The costs and benefits of promoting solar PV and wind energy'.

75 Eurostat (2014). In 2008, the latest year with data available, Germany stood at 11%, while France (6%), the United Kingdom (5%) and the Netherlands (3%) were far behind.

76 Eurostat (2014). The Netherlands stood at 1.54%, with France (1.31%) and the United Kingdom (1.19%) following suit. The EU (27) average was 1.42%. Over the period of 2001-2012 Germany was the only country to witness an increase in government budget appropriations for research and development.

77 The World Bank (2014).

78 Ibidem.

79 European Union (2013), 'EU imposes definitive measures on Chinese solar panels, confirms undertaking with Chinese solar panel exporters'.

80 International Institute for Sustainable Development (IISD) (2014), 'Germany's Green Industrial Policy. Stable Policies – Turbulent Markets: The costs and benefits of promoting solar PV and wind energy'.

81 German Solar Industry Association (BSW-Solar) (2013), 'Statistic Data on the German Solar Power (Photovoltaic) Industry'.

82 Roland Berger Strategy Consultants (2012), 'Clean Economy, Living Planet. The Race to the Top of Global Clean Energy Technology Manufacturing'.

The German wind industry currently occupies a strong global position, being among the leading global innovators and expected to remain so in the years ahead.⁸³ Together with Denmark and the UK, Germany leads the offshore wind sector. Jointly these countries registered more than 3,000 patents between 1992 and 2013, with Germany responsible for 65% of those.⁸⁴ German-manufactured wind turbines are in use both in Germany and abroad, as the manufacturers gather experience and export their services. Important players include Enercon and Siemens, together with many companies from the *Mittelstand* that provide specialised services.

Overall, the German green industry is among the most advanced in the world, owing significantly to its domestic policies which have stimulated investments in green technologies as well as to its strong manufacturing industry.⁸⁵ This pooling of political support for renewables and the development of the German industrial sector is no coincidence. A fine example of this is the renaming of the 'Ministry of Economics and Technology' to the 'Ministry of Economics and Energy' in 2013 under Merkel III. Apart from a cleaner environment and more independence from fossil imports, economic benefits and jobs are often quoted by German politicians as important reasons for this political support.⁸⁶ This is, however, not uncontested, due to the aforementioned move of PV manufacturing to China. Moreover, the increase in renewables might have also led – directly or indirectly – to job losses in other sectors such as the traditional utilities and the coal industry.⁸⁷ The net effect on jobs in the country is therefore still unknown.

The same is true for the *Energiewende's* overall effect on German industry. The German industrial base is very diverse and the effects of the energy transition materialise in many different ways, benefitting some while hurting others. What this analysis suggests is that Germany's industrial interests were taken into account when the *Energiewende* took off and the emergence of green technology companies was heavily stimulated through providing a favourable investment climate. Also, the

83 International Institute for Sustainable Development (IISD) (2014), 'Germany's Green Industrial Policy. Stable Policies – Turbulent Markets: The costs and benefits of promoting solar PV and wind energy'.

84 Windenergie Agentur (2014), 'Deutsche Offshore-Windindustrie Spitzenreiter'.

85 Planbureau voor de Leefomgeving (PBL) (2013), 'De Duitse Energiewende: Inspiratie voor Nederland?', Cleantech Group & WWF (2014), 'Coming Clean: The Global Cleantech Innovation Index 2014', and Roland Berger Strategy Consultants (2012), 'Clean Economy, Living Planet. The Race to the Top of Global Clean Energy Technology Manufacturing'.

86 See the various coalition agreements over the past decade as well as the different political programmes by the German political parties in Parliament.

87 Forbes (2013), 'Germany's Energy Goes Kaput, Threatening Economic Stability'. For more on the current issues facing utilities, please see Groot, K., Clingendael International Energy Programme (2013), 'European Utilities Under Pressure? How the electricity majors are dealing with the changing investment climate in the EU power sector' and Stapersma, P., Clingendael International Energy Programme (2014), 'Sunset or Sunrise? Electricity business in Northwest Europe'.

exemptions given to the energy intensive industry, together with the strong German influence on the new EC guidelines on public support for environmental protection and energy, indicate the strong link between German industrial and energy policy, as well as its influence at the EU level. This strong link is nothing new; certain parts of the German industrial sector have received preferential treatment before, when the country was faced with earlier energy transitions. Also, in earlier periods of industrial development, the energy industry, then coal and nuclear, were an integral part of economic transformation.

4 A GERMAN TRADITION

Before the Energiewende, Germany's electricity mix had experienced several other energy transitions. As can be observed in Figure 6, the past decades have seen new fuels enter the German electricity mix.⁸⁸

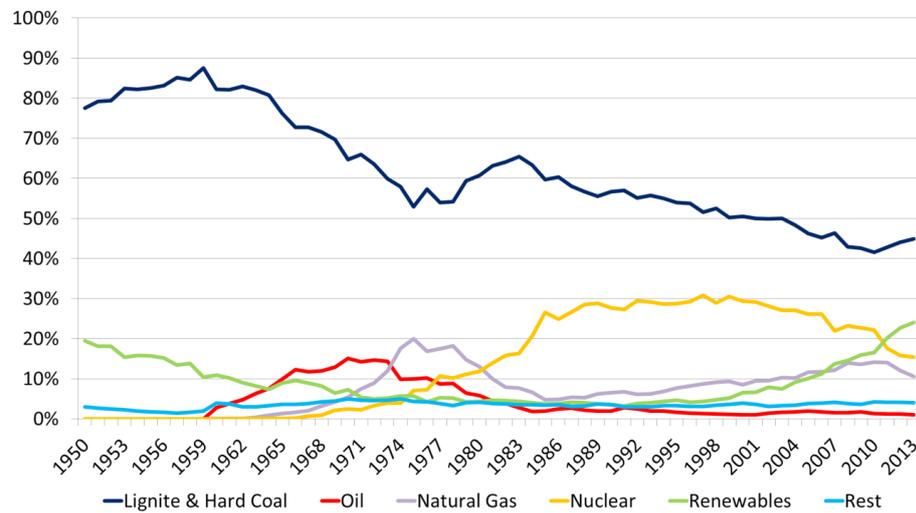


FIGURE 6. RELATIVE SHARE OF ENERGY SOURCES IN GERMAN ELECTRICITY MIX 1950-2013.⁸⁹ DATA FROM EAST GERMANY AVAILABLE FROM 1979.

What stands out from these previous developments is the dominance of coal, both in the past and the present, and the strong position of nuclear power before the Atomausstieg.⁹⁰ Other fuels such as oil and natural gas entered the German electricity mix in the 1960s but did not gain as strong a foothold as coal and nuclear did. As is the case with the Energiewende today, German industrial policy was decisive in these developments, being closely intertwined with the country's energy policy. A German tradition of approaching industrial and energy policy as a unit can be observed.

⁸⁸ In this section, Germany refers to West Germany before 1989 and the Federal Republic of Germany after reunification. Unless specifically mentioned, East Germany's electricity mix does not play a role in this analysis. This is due to the lack of data before 1979 and the absence of significant changes until 1989. See Figure 8 in the Appendix for a visualisation of this.

⁸⁹ Data retrieved from AG Energiebilanzen e.V. (2014). This data reflects the total electricity generation in Germany, including potential exports.

⁹⁰ In this paper, the term 'coal' refers to the combination of lignite and hard coal, the two forms of coal used in the German electricity mix.

4.1 THE GERMAN COAL INDUSTRY

Coal is Germany's most abundant indigenous energy source and has traditionally been the fuel of the German economy. In 1950, lignite and hard coal together provided nearly 80% of electricity generation in Germany, increasing to almost 90% in 1959.⁹¹

In 1957, German hard coal production reached an annual production peak of 150 million tonnes and employed over half a million people. At the end of the decade, however, following significant oversupply and falling world prices, it plunged into a crisis.⁹² Competing energy sources such as oil became more widely available, and this endangered the livelihoods of those working in the German coal industry.⁹³ Through the country's integrated supply chains and industrial clusters, this also affected other sectors such as the steel industry in the Ruhr area, one of the industrial centres of Germany. Coal has provided the German economy with abundant domestically produced energy for its industry, and its discontinuance could be a devastating blow to Germany's industry, economy and society. It would also make the country more dependent on imports, thereby hurting its trade balance.⁹⁴ Subsidies from the German government were introduced after the coal crisis of 1958 in order to ensure the survival of its coal industry.⁹⁵

Despite the subsidies, many coal mines were closed over the course of the following decades. Coal production declined, together with employment in the sector. Most of the coal still mined today in Germany is lignite, with hard coal being increasingly imported from abroad.⁹⁶ The German hard coal industry began to face a price disadvantage compared to foreign competition, while domestic lignite was cheaper to extract and therefore still competitive. This all greatly affected the German electricity mix over the subsequent three decades. Whereas coal accounted for nearly 90% of electricity generation in Germany 1959, by 1989 this had dropped to around 48%, even though there was no absolute decline in coal use. The relative number has stayed rather constant over the past two decades, with coal remaining the most important fuel in the German electricity mix today, a reflection of German industrial interests.

91 AG Energiebilanzen e.V. (2014).

92 Der Spiegel (2007), 'End of an Industrial Era: Germany to Close its Coal Mines'.

93 Alter, K.J. and Steinberg, D. (2007), 'The Theory and Reality of the European Coal and Steel Community'.

94 Der Spiegel (2007), 'End of an Industrial Era: Germany to Close its Coal Mines'.

95 Storchmann, K. (2005), 'The Rise and Fall of German Hard Coal Subsidies', in *Energy Policy*.

96 Statistik der Kohlenwirtschaft e.V. (2014) In 2013, 7.8 million tonnes of hard coal were mined in Germany, compared to 182.7 million tonnes of lignite. Also see: Verein der Kohlenimporteure (2014), 'Jahresbericht 2014'. Germany's main coal suppliers are Russia (25%), the USA (23%), Colombia (19%), Australia (9%), Poland (8%), South Africa (5%), and Canada (2%). Hard coal imports from the United States have almost doubled since 2010. See: Energy Information Administration (EIA).

Germany's electricity mix has witnessed the arrival of three new sources: oil, gas and nuclear energy. As can be observed in Figure 7, electricity generation increased significantly over the past decades, with new fuels constantly providing more electricity for the growing demand.

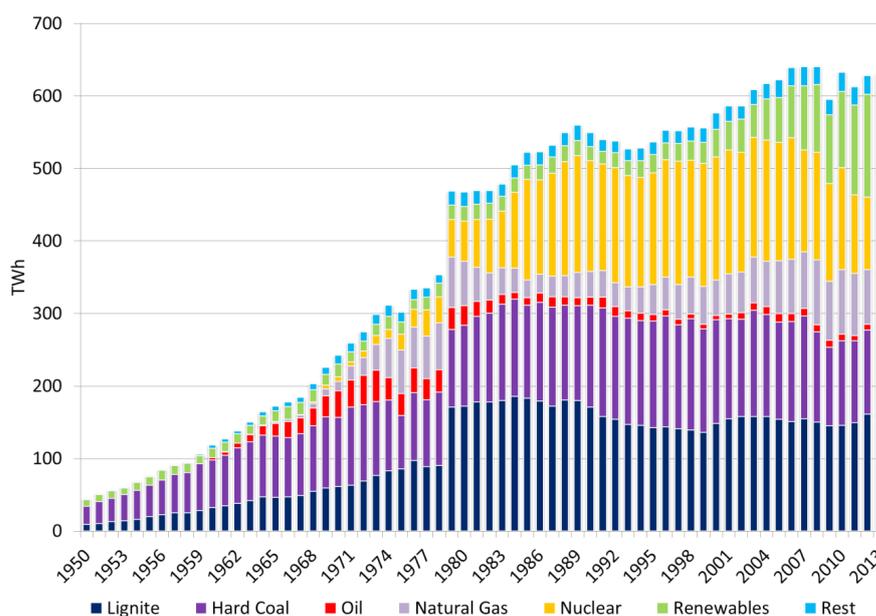


FIGURE 7. ELECTRICITY GENERATION IN WEST GERMANY 1950-1989.⁹⁷ DATA FROM EAST GERMANY AVAILABLE FROM 1979.

Oil began to be used in Germany for the generation of electricity in 1960, and by 1970 it provided 15% of Germany's electricity. The oil crisis of 1973 caused oil prices to quadruple in a few months' time, making oil-generated electricity more expensive, resulting in a significant decline – both relative and absolute – of oil's share in the German electricity mix.⁹⁸ Initially, this drop was mostly compensated by natural gas. Following significant discoveries in Russia and neighbouring the Netherlands in the 1950s and 1960s, natural gas also began to be imported into Germany, primarily for industrial purposes but also for electricity generation.⁹⁹ By 1989, however, this share had dropped to around 8% from a peak of 20% in 1975. Because the gas price was, and still mostly is, influenced by the oil price, it increased significantly as well during the 1970s, thereby making natural gas economically less interesting for

97 Data retrieved from AG Energiebilanzen e.V. (2014).

98 University of California Berkeley (2014), '1973-1974 Oil Crisis'.

99 Toth, F.L. and Rogner, H. (2006), 'Oil and Nuclear Power: Past, Present, and Future'.

electricity generation. This was further stimulated by the European Communities, who advocated the use of gas in electricity generation only as a last resort.¹⁰⁰ The same applied for the use of oil in the power sector.¹⁰¹

Whereas coal is abundantly available in Germany, oil and natural gas are not, making Germany dependent on others. As a result of this, Germany never had a national oil company such as Shell, BP or Exxon and therefore never had any national interests in oil. Apart from increasing coal production,¹⁰² the German government also focussed on developing greater nuclear capacity to increase self-sufficiency. As a result of restrictions placed on Germany after the Second World War, the country was limited in its ability to develop nuclear capabilities. However, by engaging in international co-operation, Germany was able to expand its use of nuclear power and enhance the international position of its nuclear industry.¹⁰³

4.2 THE RISE OF NUCLEAR ENERGY

Whereas nuclear energy represented only around 4% of the German electricity mix in 1974, installed capacity almost doubled the year after and continued to increase in following years. By 1989 it provided nearly 34% of total electricity generated.

Nuclear power became a prime competitor in German electricity generation for several reasons. First, it does not suffer from some of the disadvantages other energy sources have. It has low fuel costs, a vast resource base, which is also geographically more uniformly distributed than for example conventional oil and gas,¹⁰⁴ low volumes of fuel and waste, stockpiling can be done for longer periods of time, and it has a high-tech appeal and potential for large-scale spin-offs.¹⁰⁵ This last argument proved important, illustrated by the strong position occupied by the German industry in the nuclear technology business. In the search for greater energy autonomy, nuclear energy provided a clear opportunity for the German government to decrease its foreign dependency while at the same time stimulating its domestic industry. For the German industrial sector and country as a whole, nuclear power was able to provide cheap and reliable electricity. Due to nuclear having a high CAPEX and low OPEX,

100 European Communities, Council Directive of 13 February 1975 on the restriction of the use of natural gas in power stations, 75/404/EEC.

101 European Communities, Council Directive of 14 April 1975 on the restriction of the use of petroleum products in power stations, 75/405/EEC.

102 Storchmann, K. (2005), 'The rise and fall of German hard coal subsidies'.

103 See Box 3 in the Appendix for a more detailed account on the role of nuclear power in Germany after World War II.

104 Clingendael International Energy Programme (CIEP) (2006), 'Uraniumwinning, Voorzieningszekerheid, Milieu- en Gezondheidseffecten en Relevantie voor Nederland'. A major part of uranium resources worldwide can be found in what are considered stable countries such as Australia, Canada and the US.

105 Toth, F.L. and Rogner, H. (2006), 'Oil and Nuclear Power: Past, present, and future'.

acquiring the nuclear technology and constructing the power plant itself represents the majority of the investment.¹⁰⁶ If this is done within one's own country, however, that money stimulates the domestic economy. Nuclear technology consequently also became an important German export product. Kraftwerk Union AG, a company founded when Siemens and AEG merged their nuclear divisions in 1969, constructed all the nuclear power plants still operational in Germany today. They were also involved in the construction of nuclear power plants abroad in countries such as the Netherlands, Switzerland, Spain, Finland and Argentina.¹⁰⁷

Government support for specific technologies and sectors can clearly be seen at work here, illustrated by the developments portrayed in Figure 6 and 7. Domestic anti-nuclear protests, however, halted the further development of nuclear power in Germany. This was part of a wider international environmental movement which would lead to Germany's support for renewables and its abolishment of nuclear power, heralding the start of the *Energiewende* and the *Atomausstieg*.¹⁰⁸

4.3 A NEW, GREEN MILLENNIUM

When faced with energy transitions, the German government clearly uses its powers to influence the possible outcomes, taking into account factors such as energy independence, affordability and the nation's electorate. Just as with coal and nuclear, the government's support for renewables has both internal and external roots. Industrialisation had a big impact on the environment, which has not gone unnoticed; a good example is the amount of smog in the Ruhr area. For Germany, an important turning point was the moment when acid rain started to affect the country's forests in the 1970s, the same decade that anti-nuclear protests began regarding the construction of a nuclear power plant in Wyhl. After several on-site protests in 1975, the construction plans were eventually abandoned.¹⁰⁹ Anti-nuclear protests continued over the following decades throughout the entire country, driven by concerns regarding safety and environmental awareness, as well as international events such as the Three Mile Island incident in the USA, and especially the Chernobyl disaster of 1986.

Concerns about climate change began to be voiced as well, both nationally and internationally. In June 1992 the Earth Summit took place in Rio de Janeiro, an important point of discussion being the development of alternative sources of energy

106 Grimston, M. (2005), 'The Importance of Politics to Nuclear New Build'.

107 World Nuclear News (WNN) (2011), 'Siemens Quit the Nuclear Game', BBC (2011), 'Siemens to Quit Nuclear Industry', and BBC (2012), 'Finland's Olkiluoto 3 Nuclear Plant Delayed Again'.

108 Der Spiegel (2014), 'A Timeline of the Anti-Nuclear Power Movement in Germany'.

109 Ibidem.

to replace the fossil fuels causing global warming. This was accompanied by the United Nations Framework Convention on Climate Change, which aimed to stabilise GHG concentrations in the atmosphere at 450 ppm.¹¹⁰ Globally speaking, from the 1980s onwards, environmental concerns became more prominent and the Germans were a willing audience. On the 13th of January 1980 the political party *Die Grüne* was founded. Its focus was nuclear power, acid rain and the German forests, which has now expanded to environmental protection in general. The party currently holds over 10% of the seats in the German Parliament, *der Bundestag*.¹¹¹

Following these developments, the German government had to search for alternatives which would simultaneously enhance its energy security as well as support its industry. This eventually led to the introduction of the EEG in 2000 during the first ever Red-Green coalition of Schröder, as well as the *Atomausstieg* in 2002, thereby providing a precedent for the *Energiewende* and the effective start of a German green industry. Illustrative of the link between German industry and the country's energy policy was the announcement by Siemens in 2011 that it was going to withdraw from the nuclear industry entirely, the same year Merkel accelerated the *Atomausstieg* after Fukushima.¹¹² Moreover, Siemens created a separate division for its wind energy activities: Siemens Wind Power, now a leader in offshore wind turbine manufacturing in Europe.¹¹³ Both the past and the present point to a German tradition of approaching industrial and energy policy as a unit. In order to understand the drivers of the *Energiewende*, the energy transition should therefore be placed in the context of Germany's industrial policy. When predicting possible future developments of the energy transition, it is important to keep the various German industrial interests in mind.

110 See Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC).

111 Der Bundestag (2014), 'Facts. The Bundestag at a Glance'.

112 World Nuclear News (WNN) (2011), 'Siemens Quit the Nuclear Game', and BBC (2011), 'Siemens to Quit Nuclear Industry'.

113 The European Wind Energy Association (2014), 'The European Offshore Wind Industry – Key Trends and Statistics 2013', and Bloomberg New Energy Finance (2013), 'Vestas and GE Were Neck-and-Neck for Lead in Wind's Record Year'.

LIST OF ABBREVIATIONS

CHP	Combined Heat and Power
EEG	Erneuerbare Energien Gesetz
EC	European Commission
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse Gas
PV	Photovoltaics
UK	United Kingdom
USA	United States of America

APPENDIX

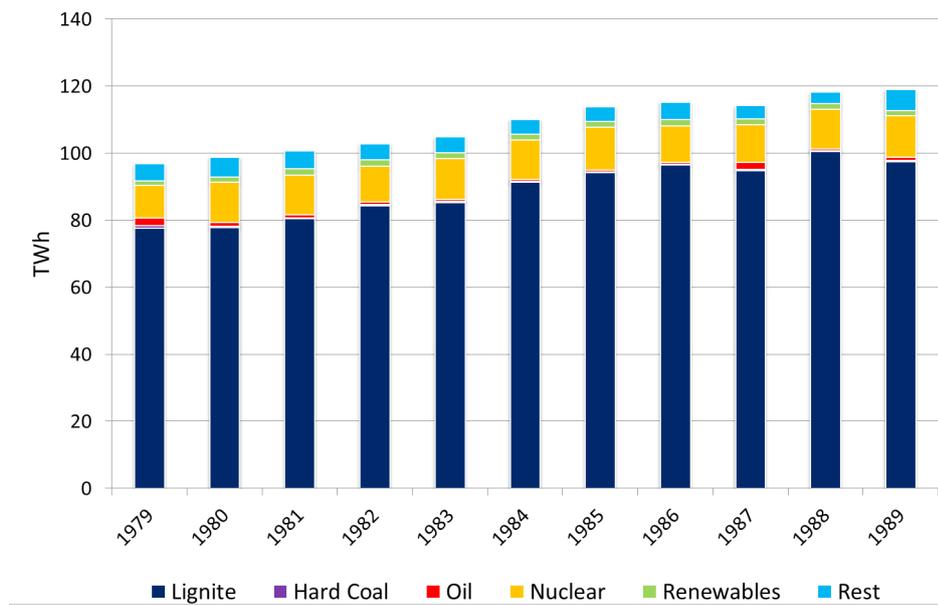


FIGURE 8. THE EAST GERMAN ELECTRICITY MIX 1979-1989.¹¹⁴

114 Data retrieved from AG Energiebilanzen e.V. (2014).

	2012	2020	2030	2040	2050
Greenhouse gases					
Greenhouse gases (base year 1990)	-24.70%	at least -40%	at least -55%	at least -70%	at least -80% to 95%
Renewables					
Share of electricity consumption	23.60%	at least 35%	at least 50% (2025: 40% to 45%)	at least 65% (2035: 55% to 60%)	at least 80%
Share of energy consumption	12.40%	18%	30%	45%	60%
Energy efficiency					
Energy consumption (base year 2008)	-4.30%	-20%			-50%
Electricity consumption (base year 2008)	-1.90%	-10%			-25%
Share of electricity production from cogeneration (CHP)	17.30%	25%			
Energy productivity	1.1% a year (2008-2012)			increase towards 2.1% a year (2008-2050)	
Buildings					
Energy demand	–				around -80%
Heat demand	–	-20%			
Renovation rate	around 1% a year			increase to 2% a year	
Transport					
Energy consumption (base year 2005)	-0.60%	-10%			-40%
Electric vehicles	10,078	1 million	6 million		

TABLE 1. GOALS OF THE ENERGIEWENDE AND THE PROGRESS AS OF 2012¹¹⁵

115 Based on Bundesministerium für Wirtschaft und Energie (2014), 'Zweiter Monitoring-Bericht "Energie der Zukunft"'. Data for 2013 is not yet available for all of the categories. See: AG Energiebilanzen e.V. (2014).

BOX 1 – A brief history of the EEG

Support for renewables started as early as 1991, when Germany first introduced an electricity feed-in law called Stromeinspeisungsgesetz. This obligated German utilities to purchase electricity generated through wind energy, solar energy, hydropower, landfill gas, sewage gas or biomass. A 5MW generator output limit was imposed for the last four. Prices varied according to source and capacity and were calculated as a percentage of the average revenue per kWh from the delivery of electricity by utilities to all final consumers.¹¹⁶ However, this proved to be rather ineffective, as can be seen in Figure 3. Between 1991 and 2000 the share of renewables increased by an average of 0.2% and 0.33% per year in the energy and electricity mix, respectively. In 2000, during the Red-Green coalition of Schröder, its successor was introduced: the EEG. Its aim was to provide more investment protection through guaranteed feed-in tariffs. Through the EEG, renewables receive preferential access to the electricity grid, and their price was fixed for a duration of 20 years. The main difference with the EEG's predecessor regarding prices was that they were no longer linked to a percentage of the retail rate. Instead, each source receives a different guaranteed price related to its generation costs and capacity.¹¹⁷ Although the EEG has been amended several times since its inception, its fundamentals have not changed. It has proven successful in its goal of increasing the share of renewables in both the energy and electricity mix, with these growing by an annual average of 0.7% and 1.6%, respectively, between 2001 and 2013.

116 Umwelt Online (2014), 'Gesetz über die Einspeisung von Strom aus erneuerbaren Energien in das öffentliche Netz'.

117 Umwelt Online (2014), 'EEG – Erneuerbare-Energien-Gesetz. Gesetz für den Vorrang Erneuerbarer Energien'.

BOX 2 – EEG Exemptions

To protect the international competitiveness of its energy-intensive industries, the German government grants these companies exemptions from the EEG-Umlage. The amount depends on the criteria displayed in Table 2, with a minimal annual consumption requirement of one GWh.

Electricity consumption	Up to 1 GWh	Up to 10 GWh	Up to 100 GWh	Over 100 GWh
EEG-Umlage	100%	10%	1%	0.05 cents/kWh

A minimum ratio of electricity costs to gross added-value of 14% is an additional requirement.

TABLE 2. THE HEIGHT OF THE EEG-UMLAGE DEPENDING ON THE ANNUAL ELECTRICITY CONSUMPTION. COSTS ARE IN EUROS.¹¹⁸

Over the past few years, the number of exempted companies has grown considerably, as can be seen in Table 3. The steep increase from 2012 to 2013 stands out from the other years and can possibly be attributed to Germany's 2013 federal elections.

Developments of the EEG exemptions	2011	2012	2013	2014
Number of exempted companies	603	734	1720	2098
Amount of exempted electricity	85 TWh	86 TWh	96 TWh	107 TWh
Share of final electricity consumption	14.0%	14.2%	15.8%	17.8%
Exempted value	2.74 billion	2.72 billion	4.0 billion	5.1 billion
Increase in the EEG as a result of exemptions	0.6 cents/kWh	0.63 cents/kWh	1.04 cents/kWh	1.35 cents/kWh

TABLE 3. DEVELOPMENTS OF THE EEG EXEMPTIONS 2011-2014. COSTS ARE IN EUROS.¹¹⁹

This surge has led to a greater share of final electricity consumption being exempted, resulting in a higher EEG for all electricity consumers because total costs have to be covered. Many of the exempted companies are part of Germany's industrial core, this having a strong focus on the manufacturing industry.¹²⁰ Excluded branches

118 Fraunhofer Institut für Solare Energiesysteme (ISE) (2014), 'Kurzstudie zur Historischen Entwicklung der EEG-Umlage'.

119 Ibidem and AG Energiebilanzen e.V. (2014). The 2014 exempted value number is an estimate.

120 Markt und Mittelstand (2014), 'EEG: Mittelständler fallen durch Befreiungsraster'.

include the chemical sector (Bayer Material Science and BASF), the steel and iron industry (ThyssenKrupp), mining (Vattenfall and RAG Aktiengesellschaft), railroad companies (subsidiaries of Deutsche Bahn), oil and gas production (ExxonMobil Production Deutschland), refining (Shell), dairy processing, meat processing and more.¹²¹ Companies that are part of the so-called green industry can also be found in the list, ranging from offshore wind (WeserWind GmbH) to solar (Bosch Solar Energy AG, Deutsche Solar).

Mostly absent from the list is the Mittelstand.¹²² Due to their small or medium size, they do not consume enough electricity to be eligible for exemptions, and/or the ratio of electricity costs to gross added value is not sufficient. The increased EEG as a result of the companies that do receive exemptions places a disproportionate financial burden on the backbone of the German economy.

121 Bundesamt für Wirtschaft und Ausfuhrkontrolle (2014), 'Unternehmen bzw. Unternehmensteile, die im Jahr 2014 an den aufgelisteten Abnahmestellen von der Besonderen Ausgleichregelung profitieren'.

122 Markt und Mittelstand (2014), 'EEG: Mittelständler fallen durch Befreiungsraster'.

BOX 3 – Germany and nuclear power after World War II

The use of nuclear energy in German power generation increased rapidly after the oil crisis of 1973, its share rising from 4% in 1974 to 34% in 1989. After the Second World War, however, Germany was forbidden from manufacturing and/or possessing atomic, biological and chemical weapons. This was a result of the negotiations at the London and Paris Conferences regarding West Germany's membership in the Western European Union. The decision in favour of membership effectively ended the Allied occupation of Germany.¹²³ It did not block the application of nuclear technology for peaceful purposes, however, and allowed Germany to develop nuclear energy for its energy mix and to create an industrial base for that. Euratom played an important facilitating role in this development. Based on active government involvement, various research programmes were started across Germany, for example in Jülich and Karlsruhe. German and foreign companies such as Siemens and Brown Boveri were also invited by the German government to develop nuclear reactor technologies and concepts.

Large German utilities such as Preussenelektra, Bayernwerk and RWE also became heavily involved in these research programmes, focussing on the development of the nuclear fuel cycle. Due to the lack of domestic uranium resources, Germany, like other European countries, was looking to enhance its supply security by developing a German industrial nuclear fuel cycle. A strong industrial base was created in both nuclear fuel assemblies (for example Advanced Nuclear Fuels GmbH in 1979) and in nuclear waste management (for example, the Asse II salt mine was used for waste storage between 1967 and 1978).¹²⁴ Certain technologies of the necessary fuel cycle were, however, considered to be sensitive. These technologies could be applied for the production of weapons-grade materials.¹²⁵ Therefore, it was decided to put these developments into international projects, notably enrichment technology (part of the front-end) and nuclear processing (part of the back-end).

As for uranium enrichment¹²⁶, the choice was made for the use of centrifuge technology, as this technology could build upon traditional German metallic experiences and could rather easily be brought into a trilateral co-operative effort

123 NATO (2014), 'Final Act of the London Conference (3rd October, 1954)'.

124 Deutsche Welle (2013), 'What to Do with Nuclear Waste?'

125 World Nuclear Association (2014).

126 Germany opted, like other Western European countries, for the light water reactor technology, which requires the use of enriched uranium as a fuel. Heavy water reactor technology, which is used for instance in Canada, is able to run on natural uranium. Enrichment is necessary, as natural uranium contains only 0.7% of the fissile isotope U₂₃₅, whereas light water reactor technology requires a level of 3-4%. The proportion of this isotope can be increased through uranium enrichment, and it is technologically possible to increase this even further, eventually reaching the so-called 'weapons grade' of 90%, which then can be used for atomic bombs.

with comparable programmes in the Netherlands and the UK. Subsequently, the Treaty of Almelo was signed in 1970. Here the German, Dutch and British governments established the industrial co-operation of Ultra Centrifuge Nederland (UCN, owned by the Dutch government), Uranit (equally divided between E.ON and RWE) and British Nuclear Fuels Limited (BNFL, owned by the UK government) into the Uranium Enrichment Company (URENCO) partnership. This was done under strong government oversight with fundamental principles for the effective supervision of the non-proliferation and security principles. These principles required, among others, the application of a number of conditions as to the use of enriched nuclear fuels, including when these fuels were exported to third countries. URENCO today has large industrial establishments in Almelo, Gronau and Capenhurst and is the world leader in applying the centrifuge technology. URENCO has also been operating in the United States of America since 2010, and France joined the tripartite partnership a few years ago. As of today URENCO holds a 31% global market share in the enrichment market.¹²⁷

As for the back-end story, Germany opted to close the whole fuel cycle. After fuel elements have been used in a reactor, they are chemically treated and the still usable uranium and newly created plutonium isotopes are separated. After quite some time, these isotopes are used again as nuclear fuel for a reactor. This process is called reprocessing. Germany had plans to build a reprocessing plant in Wackersdorf in the 1980s as part of another joint industrial partnership with France and the UK. Low uranium prices, however, diminished the business plan of the project.¹²⁸ Political and popular protests also played a role in this. Industrial-scale reprocessing of spent fuel in Europe is done today in France (la Hague) and the UK (Sellafield). Together these represent almost half of the world's total civil capacity of commercial reprocessing.¹²⁹

The fission product of plutonium, created through reprocessing, can be used to make (or breed) more plutonium as well, also generating electricity in a so-called fast breeder reactor.¹³⁰ To achieve this, Germany again engaged in international co-operation to enhance its nuclear industry further. The plan was to build a sodium-

127 URENCO (2014).

128 M. Schneider and Y. Maignac (2008), 'Spent Nuclear Fuel Reprocessing in France'.

129 World Nuclear Association (2014).

130 Ibidem.

cooled fast breeder reactor near Kalkar, Germany, together with the Netherlands and Belgium. Research institutes had already started to co-operate back in 1965, and several memoranda of understanding at industrial and government levels were concluded in 1967 to start the construction of a first SNR 300 fast breeder reactor.¹³¹ High costs, technological developments and cheap energy were cited by the Dutch government in support of the project. Germany financed 70%, with Belgium and the Netherlands contributing 15% each.¹³² The Dutch (with Neratoom) focussed on the sodium technology, the Belgians (Belgonucléaire) developed the fuel rods, and the Germans (Interatom and Siemens) designed the nuclear reactor.¹³³ Although cheaper French (Phénix) and British (PFR) designs of breeder reactors of comparable unit sizes already existed and were under construction, the SNR 300 design by the Germans was chosen for Kalkar, clearly indicating a national preference.¹³⁴ The first partial construction permit was granted in March 1973, and construction began quickly. Rising costs and increasing public resistance made the Dutch and Belgian governments cap their financial contributions. Nonetheless, Germany completed construction in 1985 despite increased public doubts about the safety of the use of plutonium. Almost 40,000 people had taken to the streets of Kalkar in 1977 to protest the fast breeder reactor's construction, a movement later reinforced by the Three Mile Island incident of 1979 in the United States of America. As a result, the fast breeder reactor never became operational and was abandoned in 1991. This public opposition to nuclear projects was part of a wider international environmental movement which would lead to Germany's support for renewables.¹³⁵

131 Marth, W. (1994), 'The SNR 300 Fast Breeder in the Ups and Downs of its History'.

132 Originally Luxemburg participated in this project but later pulled out.

133 The German side would later undergo a few changes when Siemens acquired a 60% interest in Interatom in 1969. The other partners would later withdraw, leaving Siemens as the sole owner. It thereafter transferred its shares to Kraftwerk Union AG, where it had staked its nuclear divisions together with AEG.

134 Marth, W. (1994), 'The SNR 300 Fast Breeder in the Ups and Downs of its History'.

135 Der Spiegel (2014), 'A Timeline of the Anti-Nuclear Power Movement in Germany'.



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