Deloitte.

European energy market reform
Country profile: Germany

Contents

Current situation

Energy consumption and trade balance

Germany's gross inland energy consumption[1] stood at 319 Mtoe in 2012 and has experienced a steady downward trend over the last two decades: a decrease of 3.9% from 1990 to 2000, and of -7% from 2000 to 2012. More than 80% of consumption came from fossil fuels. Petroleum products constituted the lion's share of the mix (108 Mtoe), followed by coal (80 Mtoe) and gas (70 Mtoe). Although the role of renewables is steadily increasing, their share remains relatively modest (10%).

Figure 1. Gross inland consumption in 2012 (319 Mtoe)[2]

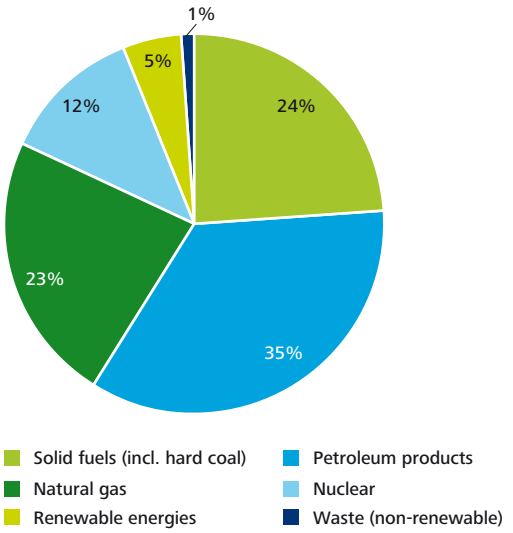
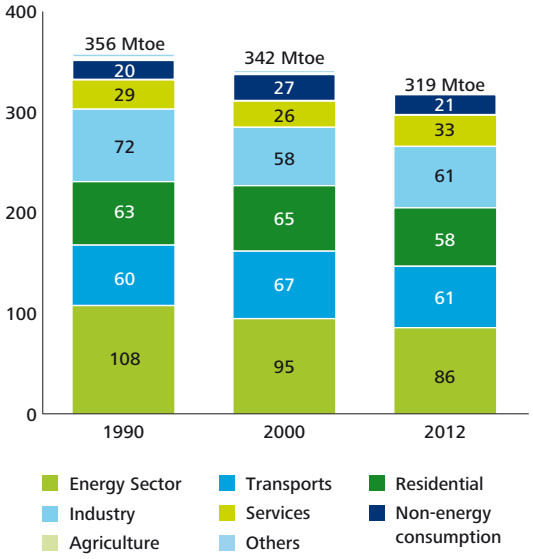


Figure 2. Gross inland consumption by sector (in Mtoe)[3]



The energy sector made up 27% of gross consumption in 2012, equivalent to the year 2000. From 2000 to 2012, the decrease in energy consumption was mainly driven by the energy sector (-9.5%), transport (-8.9%), the residential sector (-11%) and non-energy related fossil fuel consumption (-22%).

Key figures:

Population (2013):
80.5 million

GDP (2013):
2,737 bn €

GDP/capita (2013):
33,997 €

GDP/PEC (2012):
9.2 €/kgoe

PEC/capita (2012):
3.7 toe/cap.

Fossil fuels make up more than 80% of Germany's gross inland energy consumption.

The energy sector represented 27% of gross energy consumption in 2012; its volume decreased by 9.4% as compared to 2010.

1 The gross inland energy consumption is equal to the primary energy consumption plus the consumption of fossil fuels for non-energy purposes

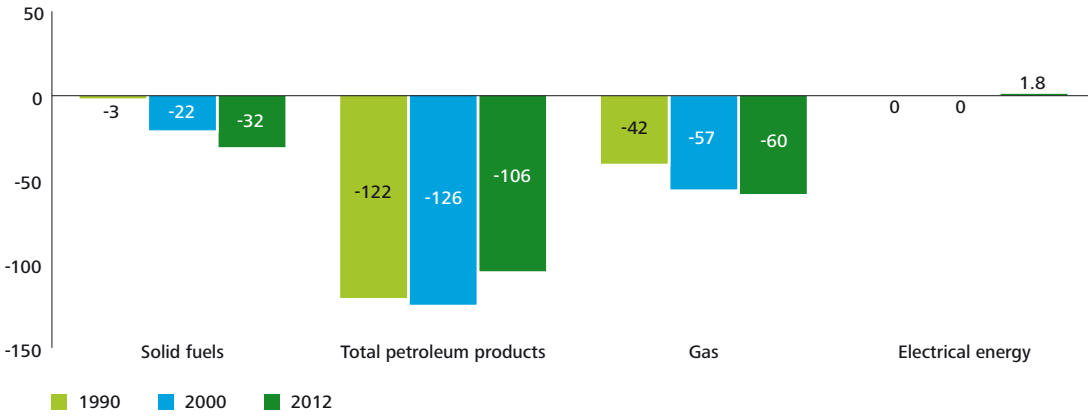
2 Source: Eurostat. © European Union, 1995-2015

Germany depends heavily on fossil fuel imports.

Germany's net imports reached a record high of € 93.5 billion in 2012.

Coal and gas net imports continue to rise steadily, whereas net imports of petroleum products decreased between 2000 and 2012 (-16%).

Figure 3. Energy trade balance (Mtoe)[2]



Over the same period, energy consumption rose by 5% in the industrial sector and by 27% in the services sector.

In 2012, German net imports of oil, gas and coal reached a record high of € 93.5 billion[3] (€ 68 billion for petroleum products, € 23 billion for gas, € 2.5 billion for coal), accounting for 10.2% of total imports[4] for the year. Although Germany is the world's largest miner of lignite, coal imports have been on the rise over the last two decades.

The same holds true for gas, where inland production decreased by 40% between 1990 and 2012 and imports increased by 80%.

44% of the country's electricity production relies on coal, while one third stems from renewables.

Power generation

With over 180 GW of installed capacity, Germany's is the largest electricity market in Europe. Over the last decade, the German energy markets have experienced fundamental changes largely driven by the continuous expansion of renewables and the abrupt decision after the Fukushima accident in 2011 to phase out nuclear power by 2022, which has become one of the cornerstones of Germany's energy market turnaround (*Energiewende*[5]).

Figure 4. Electricity capacity – 183 GW (2013)[6]

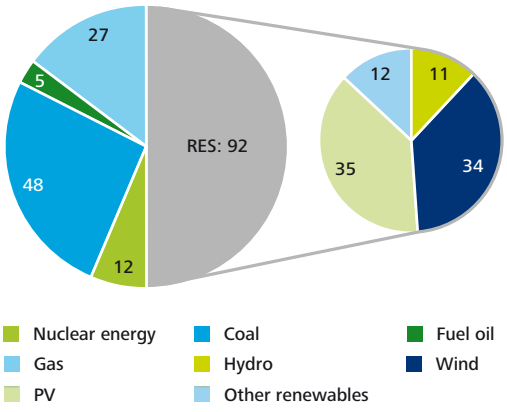
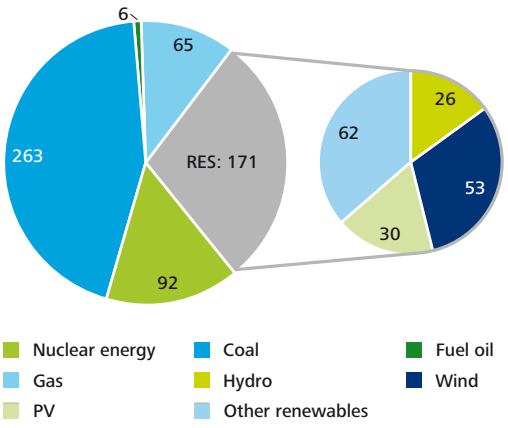


Figure 5. Net electricity production – 596 TWh (2013)[6]



Coal is the main source of fuel for electricity generation, and represented 44% (263 TWh) of generation output in 2013.

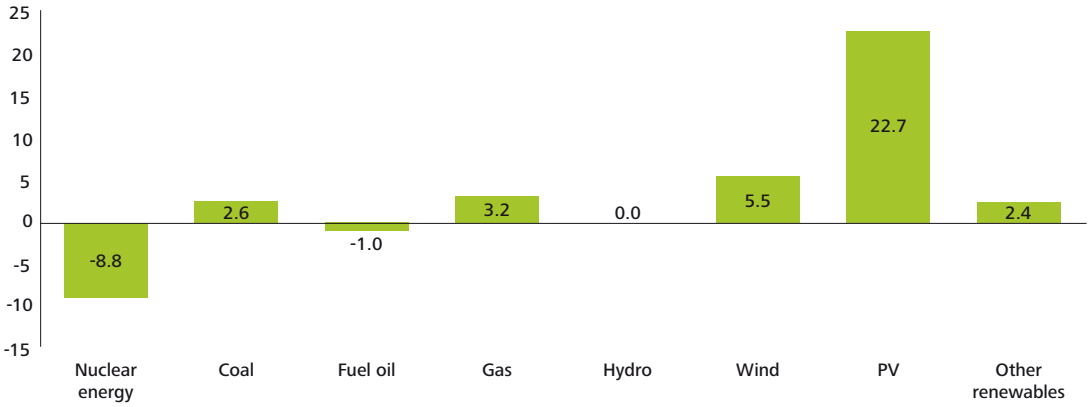
3 www.bafa.de

4 www.destatis.de

5 The *Energiewende* is explained in more detail in the third chapter of this country profile

6 RWE, BMWi

Figure 6. Electricity capacity change from 2009 to 2012 (in GW)[6]

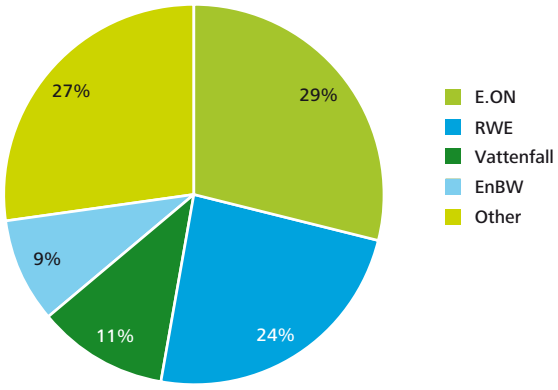


Renewable energy represented 50% of the total generation capacity, and 29% of electricity production. Nuclear still accounted for 7% of installed capacity, generating 15% of the electricity.[6]

From 2009 to 2012, Germany added 26.7 GW of generation capacity, most of which was driven by PV and wind. The immediate shutdown of eight nuclear reactors led to a sharp drop in nuclear capacity. Since peak capacities from renewables need to be balanced, coal and gas capacity increased over the last few years.

Power market: market mechanism and main actors

Figure 7. Market share of electricity generation (2012)[7]



Germany's domestic electricity market was fully liberalized in 1998. **Although there are currently over 800 individual providers, the majority of the country's electricity is still generated by four big energy companies: E.ON, RWE, Vattenfall and EnBW.**

Although shutting down the eight nuclear power plants reduced their generation capacities, **the four companies still produced 73% of electricity in 2012**.[7]

6 RWE, BMWi

7 Monitoring Report 2012 – Developments of the electricity and gas markets in Germany; calculations reproduced with information extracted from annual reports of the companies

Four players dominate the power market and four TSOs operate the grid.

The German power market is liberalized, but dominated by four main players who account for 73% of electricity generation. The grid is operated by four TSOs who historically were owned by the four big energy generators. More than 900 DSOs currently operate in the country.

The German transmission system is the most important hub in the European electricity market. **There are four TSOs** (transmission system operators); **one is still owned by a German energy utility, EnBW**:

- Amprion GmbH operates the largest system in Germany (11,000 km) and was sold in 2011 by RWE to a consortium of financial investors.
- TenneT operates 10,700 km. This grid was sold by E.ON in 2010 to the Dutch TSO.
- Elia (50Hertz Transmission GmbH) operates 9,750 km; the grid was purchased from Vattenfall by the Belgian TSO in 2011.
- TransnetBW GmbH operates 3,300 km and is still owned by EnBW.

Figure 8. Market mechanism

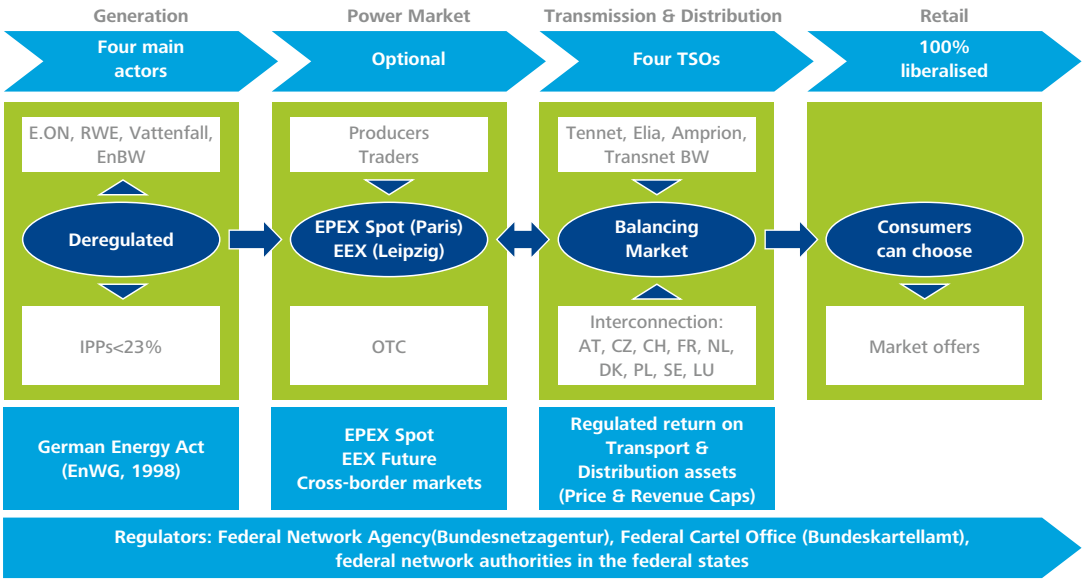


Figure 9. Geographical division of the transmission system by operator

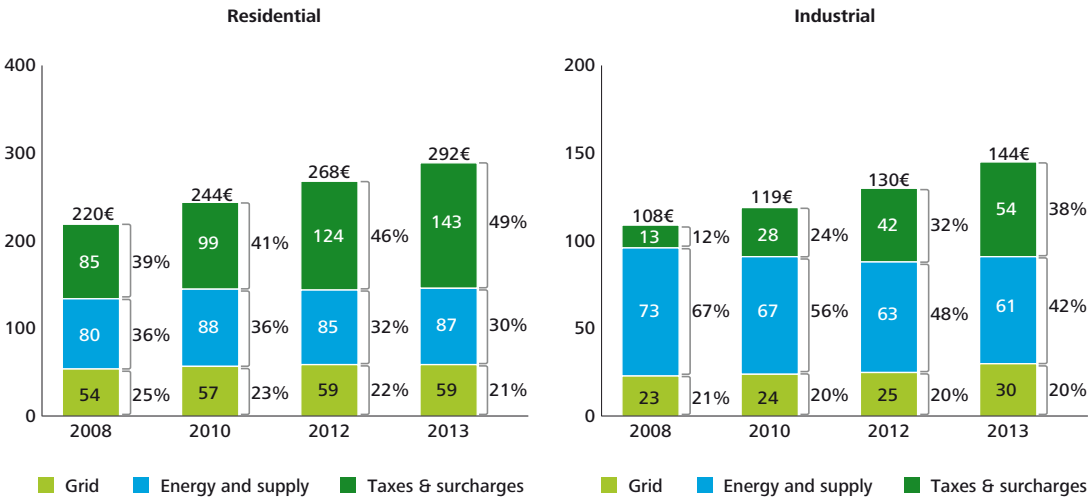
In 2013, more than 900 DSOs (distribution system operators) **were operating in Germany**. The distribution networks are often run by vertically integrated utilities, companies that own generation assets as well as supply and distribution businesses. The country's four dominant companies hold shares in many of these DSOs.

Power prices

Germany has the second highest residential electricity prices in the EU-28 (after Denmark): 45% above the EU-28 average price.

Prices for industrial users are 21% above the EU-28 average, ranking fourth after Cyprus, Malta and Italy, although industrial users pay less than 50% of the residential tariff.

Figure 10. Retail prices for residential and industrial users (€/MWh)[8]



Electricity prices rose sharply between 2008 and 2013: +32% for residential users and +33% for industrial users.

While generation and distribution costs remained relatively flat, **the main driver of the significant overall cost increases is linked to taxes and surcharges, which include subsidies to suppport renewable development (the so-called EEG surcharge, see next chapter).**

In 2013, the EEG surcharge made up 36% of the tax burden and 18% of the overall electricity price, compared to only 5% in 2008. It has risen steadily from 11 €/MWh in 2008 to 62 €/MWh in 2014 (CAGR: 33.4%).

High and increasing power prices.

In 2014, the renewable energy sector was subsidized to the tune of approximately € 24 billion. Electricity prices have been rising over the last few years, mainly driven by the significant expansion of renewable capacities. The lion's share of the costs of renewables is borne by household consumers. German electricity prices are the second highest in Europe for residential users and the fourth highest for industrial users.

8 Source: Eurostat. © European Union, 1995-2015 (ten00117 – Residential: 2500 kWh < cons. < 5000 kWh; Industrial: 500 MWh < cons. < 2000 MWh)

Figure 11. EEG-surcharge[9]

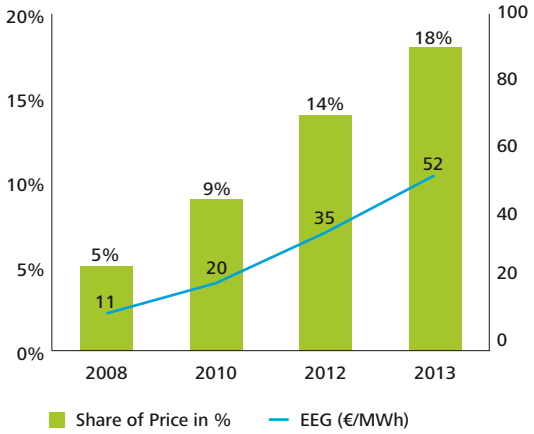
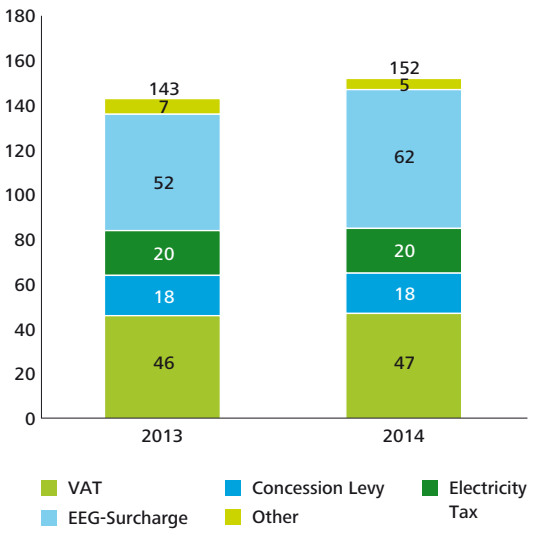


Figure 12. Tax breakdown[9]



Although PV only generated approximately 17% of the renewable electricity in 2013, it accounted for 53% of the EEG costs, almost three times as much as wind (18%) and twice as much as biomass (26%).

9 BDEW

Targets for 2020

In 2010 and 2011, the German government set energy and climate targets for 2020 and 2050 (2010 Energy Concept and 2011 Energy Package):

Table 1. Targets fixed in the Energy Concept[10]

	Targets	2020	2030	2040	2050
Energy efficiency	Reduction of primary energy consumption (base year: 2008)	20%			50%
	Reduction of electricity consumption (base year: 2008)	10%			25%
	Reduction of final energy consumption in the transport sector (base year: 2005)	10%			40%
Renewable energy	Share of renewable energies in electricity consumption	35%	50%	65%	80%
	Share of renewable energies in total final energy consumption	18%	30%	45%	60%
GHG	Reduction in GHG emissions (base year: 1990)	40%	55%	70%	80%-95%

In 2011, after the Fukushima accident, the German government decided on a radical energy turnaround (*Energiewende*), phasing out nuclear power by 2022, although the 2010 Energy Concept initially intended to keep nuclear energy in the mix as a so-called "bridge transition technology."

The Energy Package of 2011 contains six measures that build a framework for the energy turnaround:

- Accelerate the construction of the energy grid (NABEG).
- Redefine energy sector-related laws and ordinances (EnWGÄndG).
- Create an energy and climate fund (EKFG-ÄndG).
- Change the Atomic Energy Act (AtomG).
- Enforce climate-friendly development in cities and communities.

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Energy efficiency targets

Germany's energy intensity has been decreasing over the last 20 years. While its GDP rose by 82% between 1990 and 2012, its primary energy consumption in 2012 had decreased by 5% compared to the 2008 level.

In June 2014, the federal government adopted the third National Energy Efficiency Action Plan (NEEAP), with a primary energy consumption target of 277 Mtoe in 2020 (vs. 315 Mtoe in 2008 and 298 Mtoe in 2012), representing a decrease of 12% compared to 2008.

This target assumes a 1.1% annual GDP increase and an average annual increase of 2.1% in macroeconomic energy productivity from 2008 to 2020.

As of 2012, Germany still needed to decrease its primary energy consumption by 21 Mtoe before 2020. Notably, **between 2008 and 2012, Germany realized 46% of its energy efficiency target, and is consequently on track to reaching its 2020 targets**.

20-20-20 EU targets for Germany: what is Germany committed to in 2020?

- 20% reduction of primary energy consumption compared to 2008 levels.
- 18% renewable energies in 2020 final energy consumption and 35% renewable energies in electricity consumption in 2020.
- 40% reduction of GHG emissions in 2020 versus 1990 levels in total.

Energy efficiency: so far, 54% of Germany's target has yet to be accomplished.

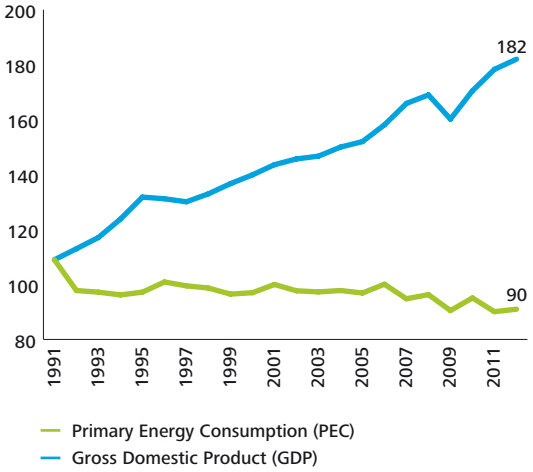
Germany's primary energy consumption has been on a declining trend over the last 20 years. To reach its 2020 targets, it must still reduce consumption by 21 Mtoe (7% of its 2012 consumption).

Germany seems to be on track to reaching its 2020 targets. However, future success will strongly hinge on the effectiveness of its energy efficiency policies, especially in the buildings sector.

10 BMWi

Figure 13. Primary energy consumption (Mtoe) and 2020 target[11]

Figure 14. GDP and PEC development[11]

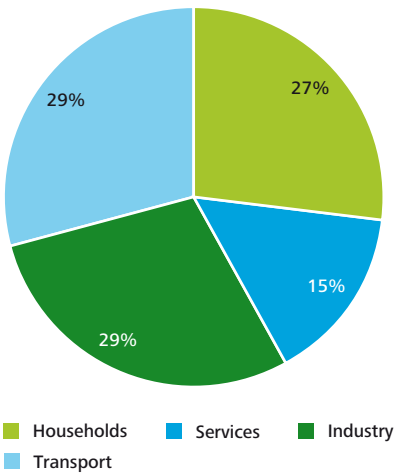


According to the third NEEAP, the target for *final* energy consumption was fixed at 194.3 Mtoe in 2020. The buildings sector is a primary target for overall energy efficiency improvement as it consumes almost 40% of Germany's final energy. In the 2010 Energy Concept, the target was to reduce heat demand by 20% and to have all new buildings become "climate-neutral" by 2020. By 2050, all existing buildings should be climate-neutral. Furthermore, primary energy demand in the building sector should be reduced by 80% by 2050. This will require a doubling of the renovation rate of buildings, from around 1% at the moment to 2% per year, accompanied by significant investments. The recent update of the Energy Saving Ordinance (EnEV 2014) increased the energy efficiency requirements for new and refurbished buildings by 25% from 2016. For its part, the Renewable Heating Act (2011) prescribes the integration of renewables or CMP for new and replaced heating systems.

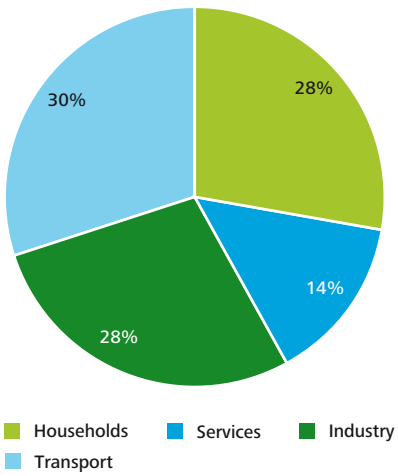
The KfW, a government-owned development bank, provides loans and grants to refurbish old and new buildings to levels that exceed the minimum energy performance requirements set by the Energy Savings Ordinance (€10.4 bn in 2013). Between 2013 and 2020, the government has committed to increasing these yearly grants by an additional € 300 million.

Figure 15. Final energy consumption in 2012 and 2020 targets, by sector[12]

Final Energy consumption 2012: 213 Mtoe



Final Energy consumption 2020: 194 Mtoe



11 Source: Eurostat. © European Union, 1995-2015

12 http://ec.europa.eu. © European Union, 1995-2015

The transport sector accounts for around 30% of Germany's final energy consumption. Policies related to the energy efficiency target mainly concern the technical improvement of vehicles. In its Energy Concept, the German government set a target to reduce final energy consumption in the transport sector by 10% in 2020, as compared to 2005. However, as of 2012, only 5% of this reduction had been realized, leaving 95% still to be achieved.

Like the transport sector, the industrial sector accounts for almost one-third of the country's final energy consumption. The EU-ETS aims to incentivize energy-intensive industries and the electricity sector to reduce their emissions and consequently enhance overall energy efficiency. The German Development Bank, KfW, introduced an Energy Efficiency Program for SMEs in 2012, providing loans for private companies and self-employed persons to finance energy saving investments (up to € 25 million). SMEs with an annual energy bill of over € 5,000 can also apply for an energy audit provided by KfW. Furthermore, companies can receive investment grants to increase the energy efficiency of their production processes. Another measure geared towards industry is the Surplus Settlement Efficiency System Act (SpaEfV),[13] which defines criteria to qualify for a partial refund of energy and electricity taxes, as well as for partial relief on EEG-surcharges in cases where specific energy efficiency requirements are met.

Renewable energy targets

Germany's renewable energy targets aim at reaching an 18% share in total final energy consumption and a 35% share of electricity consumption by 2020.

An ambitious but costly policy to develop renewables in the power sector:
Development of renewable energy has been subsidized with a price guarantee to renewable energy producers. The following table shows the feed-in tariffs and contract durations in 2014.

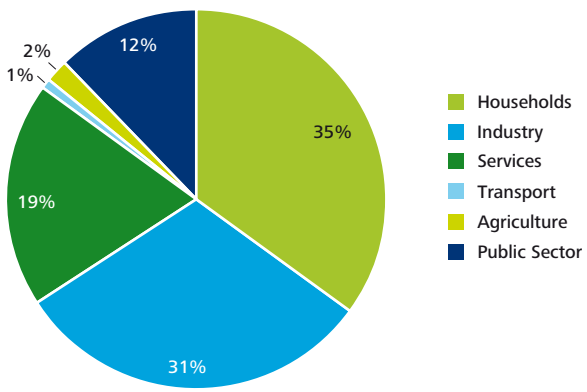
Table 2. 2014 feed-in tariffs (in c€/kWh) and contract durations (years)[14]

	Onshore wind	Offshore wind	Solar	Geothermal	Biomass (CHP)
Feed-in tariffs (c€/kWh)	4.9-8.9	3.9-19.4	8.7-12.8	25.2	5.8-13.6
Contract duration (years)	20	20	20	20	20

The difference between the market price for electricity and the guaranteed price to producers for renewables is passed on to consumers (via the EEG surcharge), whose bills have been rising for years. **Currently, the renewable energy sector is subsidized to the tune of approximately € 19.4 billion per year (€ 240 per resident in 2014[15])**.

In 2014, approximately 3,000 companies, accounting for around 107 TWh, or 18% of total electricity consumption, were fully or partially exempt from paying the EEG surcharge, meaning that a big share of the extra costs of renewables is being shouldered by households.[16]

Figure 16. Financing of the EEG surcharge, by sector[16]



Renewable energy: 66% of the country's target has been achieved so far, although reaching the final target remains uncertain.

Germany currently generates 12% of its final energy consumption and 23% of its electricity from renewables. These shares have been rising continuously in recent years. New capacities will stem mainly from wind and solar.

If current trends prevail, Germany will be well on its way to reaching its 2020 targets. However, recent changes in the EEG may slow down the future development of renewables, hindering the country's ability to reach its targets.

13 Spitzenausgleich-Effizienzsystemverordnung (SpaEfV)

14 EEG 2014, for solar with monthly degression (actual Nov. 2014)

15 http://www.wiwo.de/politik/deutschland/trotz-reform-verbraucher-werden-2015-eine-milliarde-euro-mehr-eeg-umlage-bezahlen/9414526.html

16 BDEW (2014)

Although the majority of Germany's population is generally supportive of the *Energiewende*, rising pricing inequality has eroded popular support over the last four years.

In June 2014, the federal government revised the EEG to limit electricity price hikes. The new law set specific volume targets (so-called expansion corridors) for the annual increase of each renewable energy technology:

- Solar: annual increase of 2.5 GW.
- Onshore wind: annual increase of 2.5 GW.
- Biomass: annual increase of 100 MW.
- Offshore wind: 6.5 GW until 2020 and 15 GW until 2030.

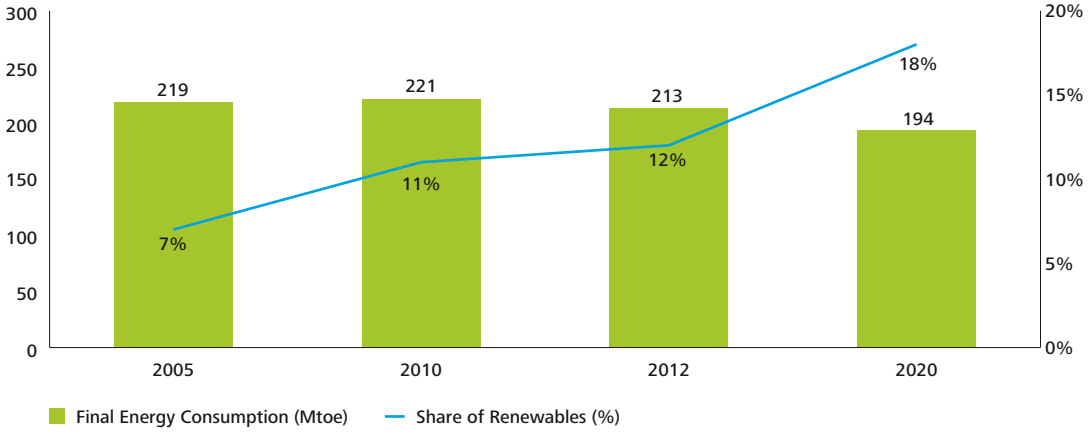
If more new plants are built to support more than the projected capacity, the subsidy rates for additional plants will automatically be reduced (flexible cap).

Additionally, to reduce the high surcharge, these reforms aim to spread the cost to more customers by reducing the number of exempt industrial customers and applying the surcharge to customers that generate their own power.

In October 2014, the German government announced that – for the first time in its history – the EEG surcharge for residential and for non-relieved commercial and industrial customers would fall slightly in 2015, to 61.7 €/MWh, mainly resulting from a surplus of EEG-surcharges from 2013.

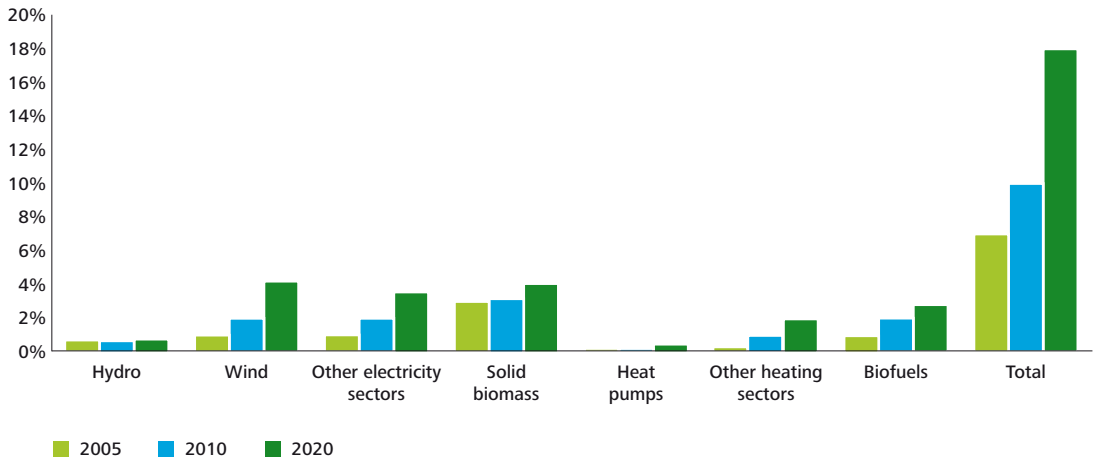
Where is Germany now regarding renewable energy?
Between 2005 and 2012, Germany increased its share of renewables in final energy consumption from 7% to 12%, and its share of renewables in gross electricity consumption from 10% to 23%. This means that 1/3 of the target still remains to be realized before 2020.

Figure 17. Renewable energy share of final energy use (2012)[17]



17 Source: Eurostat.
© European Union, 1995-2015

Figure 18. Renewable energy share of final energy use by type, in 2005 and 2010, and target for 2020, in %[18]



The increasing share of renewables was mainly driven by new PV and wind capacities: PV capacities rose from 62 MW in 2000 to 34.7 GW in 2013 (CAGR: 63%), overtaking wind capacities. And wind capacities increased during the same time, from 5.8 GW to 34.4 GW (CAGR: 15%).

As can be inferred from **Figure 18, the main sources of additional renewable energy capacities until 2020 are targeted to come from wind** and other electricity sectors, mainly PV. Germany seems to be on track to reach its renewable energy targets.

However, with the EEG reforms of 2014, which reduced feed-in tariffs and introduced capacity caps, development is likely to slow down. Another impediment to the implementation of new capacities will be the speed with which the new electricity grid can bring energy from the windy north to the energy-hungry south in the face of both administrative barriers and local opposition.

To date, Germany has reached 66% of its renewable energy target. However, given changing policies around renewable power, its ability to reach its 2020 target remains uncertain.

CO_2 emissions and targets

Germany is the largest CO_2 emitter in Europe, accounting for roughly 20% of the overall EU-28 CO_2 emissions in 2012. These emissions have been declining over the last two decades, falling 25% below 1990 levels. However, emissions regained momentum after the country's decision to phase out nuclear power in 2011, and have increased over the last two years due to a higher share of coal (in particular lignite) in the electricity generation mix. **Preliminary numbers suggest that in 2013 emissions further increased to 951 Mt CO_2eq.**[19] These increases can mainly be attributed to the energy sector (+3%), the transport sector (+5%) and the residential sector (+3%).

18 Eurostat. © European Union, 1995-2015

19 http://www.umweltbundesamt.de/

CO_2 emissions: 62% of the target achieved, but emissions are on the rise.

Germany cut its emissions by 25% relative to 1990, but has experienced increased CO_2 emissions since the rapid shut down of eight nuclear plants in 2011. With its high dependence on coal and 11.5 GW of coal plants under construction, it is highly questionable if the remaining 38% of CO_2 reductions can be met by 2020.

Figure 19. GHG emissions and targets[20]

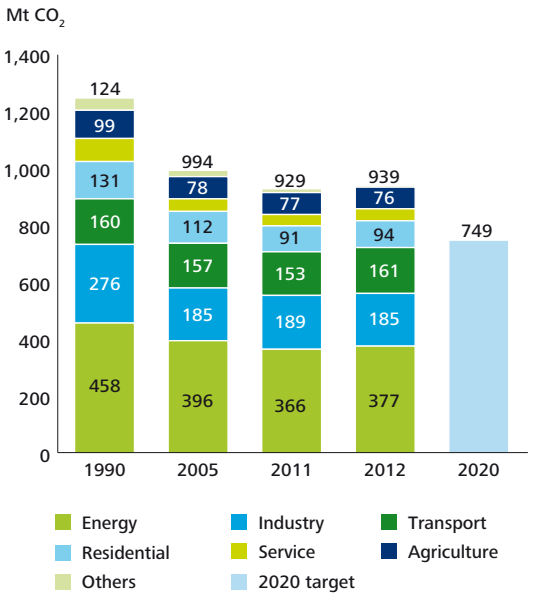
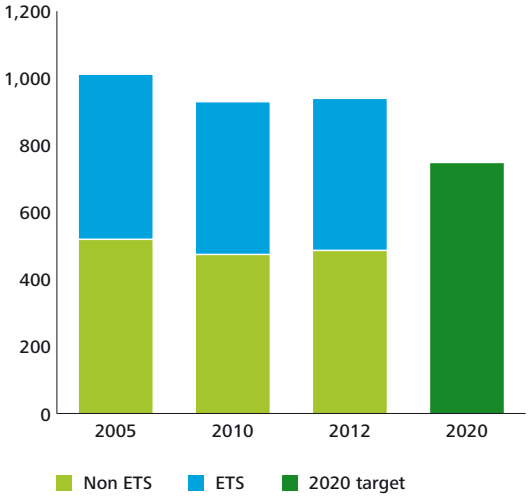
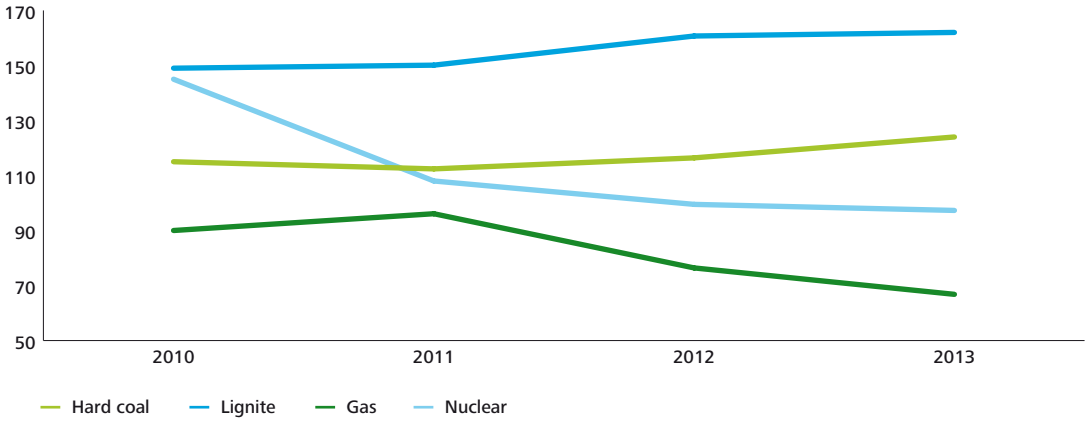


Figure 20. ETS and non-ETS emissions[21]



ETS emissions have been on the rise since 2009, a trend partly attributable to the country's economic recovery. While future CO_2 prices will certainly influence Germany's GHG targets, further significant efforts to reduce both ETS and non-ETS emissions will be required.

Figure 21. Electricity generation from coal, gas and nuclear (in TWh)[10]



Current Ministry of the Environment projections suggest that measures in place should lead to an overall emission reduction of 33% as compared to the 1990 level. **Closing the gap to reach the 40% target would require additional savings of around 85 Mtoe of CO_2eq, meaning that further action is necessary**. Yet, if coal maintains or even increases its considerable share in the German energy mix,[22] the *Energiewende* might impede the country's ability to reach its 2020 targets.

To counteract this development, the government presented its first cornerstones for a 2020 Action Program for Climate Protection[23] in April 2014.

Building on this Action Program, the government plans to develop a national 2050 Climate Protection Plan by 2016. It is, however, unlikely that these measures will be very effective before 2020, which means Germany is unlikely to reach its 2020 CO_2 targets.

20 EEA (2014)

21 VET-Bericht 2013, Treibhausgasemissionen der emissionshandel-spflichtigen stationären Anlagen in Deutschland im Jahr 2013, German Emissions Trading Authority (DEHSt) at the Federal Environment Agency

22 WWF (2014): According to a study published by environmental groups including WWF four of the five most polluting coal power plants in Europe are situated in Germany

23 Aktionsprogramm Klimaschutz 2020

Road ahead and main challenges: the way to 2030 and beyond

Energy turnaround (Energiewende)

Germany has set ambitious energy and climate targets for 2050, with interim steps for 2030 and 2040. It was one of the first countries to set up long-term objectives to move toward a low-carbon economy. This endeavor has proven – and will most likely continue to prove – costly to German taxpayers. In February 2013, the then Energy & Environment minister said that the costs of *Energiewende* – reforming and restructuring Germany's energy sector by the end of the 2030s – could reach € 1,000 billion.

These targets, combined with the simultaneous phase-out of nuclear energy by 2022 and the increasing costs to support the development of renewable energy, constitute a major challenge to Germany's ability to guarantee a secure and affordable energy supply. This threatens not only citizens' living standards, but also the competitiveness of Germany's economy.

To the German public, these targets are indicators of the country's ability to complete its energy transition in a timely manner. It remains to be seen whether Germany's policy-makers see the timely achievement of these targets as an end in itself (as a way to avoid political risk and argue in favor of shorter-term expensive fixes) or whether they are serious about adopting a strategy capable of driving down costs and encouraging innovation by fostering exposure to prevailing market forces.

Ambitious targets require ambitious actions – and a more adaptive energy environment.

Germany presented a legal framework to pave the way for its 2020 and 2050 targets. However, it is not clear if this framework will be sufficient.

Nuclear power

Nuclear plants supplied approximately one-quarter of Germany's power before the 2011 Fukushima accident. This disaster changed the German energy strategy in a radical way. The eight oldest reactors (8.8 GW) were permanently shut down in mid-2011 and the government decided to speed up the shuttering of the nine remaining reactors (12.7 GW) by about a decade, to 2022. **In 2013, nuclear generated 97 TWH or 16% of the country's electricity output**.

As an illustration, replacing 97 TWh of nuclear power production would require around 112 GW of new PV, 63 GW of wind or 18 GW of coal power capacities.[24]

Since the nuclear phase-out has broad acceptance among the population and is supported by all the major political parties, it is rather unlikely that another U-turn will occur in the years to come. In September 2011, industry giant Siemens announced its complete withdrawal from the nuclear industry.

This last point demonstrates a critical side effect of the government's decision. Since there is no future role for this type of energy in Germany, specific know-how and technologies will not be developed beyond the current generation. Yet, this know-how will still be needed to decommission the existing power plants. Another major and still unresolved problem is linked to the management of nuclear waste, which is a highly controversial topic in Germany. An operating repository for high-level waste is not expected before 2050.

In essence, the nuclear sector is heading towards a "bad bank" scenario, where the German government may need to take a more active role in organizing and financing the shutdown of the sector – in a manner similar to what happened in the German hard coal mining sector.

12.7 GW of nuclear plants are slated to be gradually replaced between 2015 and 2022, representing 16% of the country's 2013 electricity output.

While replacing nuclear energy seems a stretch but possible, the real challenge lies in shutting down the sector. To achieve this goal, the state will likely need to play a more active role.

Renewables

According to the Energy Concept, renewable energies are the supporting pillar of Germany's future energy supply. The target is for renewables to reach a 60% share of final energy consumption and 80% of electricity production by 2050. Over the past decade, Germany saw a strong expansion of its intermittent energy sources. Wind power has become the most important renewable source of electricity production, with an installed capacity of 34 GW in 2013, followed by solar power, which grew sharply over the last five years (+22.7 GW between 2009 and 2012).

While this development has led to a significant increase of renewables in the German energy mix, it was accompanied by lower (and sometimes even negative) spot prices on the energy exchanges and a crowding-out effect of operating times of conventional power plants (for gas in particular).

In parallel, electricity bills are rising sharply as a result of the cost of the surcharge used to fund renewables. Even if the German government manages to regulate the annual capacity increase, it still remains to be seen how the population's energy bill can be kept at an acceptable level and how it will impact Germany's competitiveness. From 2008 to 2014, the EEG apportionment for residential customers rose from 11 to 62 €/MWh (+460%).

More renewables in the pipeline, but at what cost?

Although development is likely to slow down in the coming years, additional capacities are planned. Yet zero-marginal cost economics will, fundamentally reshape the way energy is procured in the long term.

24 Calculation based on the 2013 TWh/GW ratios; cf. the chapter on power generation

Nevertheless, renewables in the form of onshore and offshore wind, as well as PV, will continue to be the only growing forms of energy in Germany for the foreseeable future. With the system becoming increasingly dominated by renewables, two issues are coming to the fore:

- Storage. The abundance of cheap energy during times of oversupply, combined with the need for grid balancing, will foster innovation in storage solutions such as direct battery storage, indirect power-to-heat and power-to-hydrogen applications.

- Financing. Given the zero-marginal cost of renewables, the relevance of wholesale market prices to refinance renewables investments will likely be called into questioned. Instead, other forms of asset monetization, such as long-term PPAs, may be used to finance capital costs, leaving only residual balancing energy to be traded.

Fossil fuels and peak power production

11.7 GW of new coal, threatening GHG emission targets.

With low CO_2 prices and a relatively high gas price in Europe, coal could remain attractive for several years, threatening Germany's long-term GHG emission targets.

Germany relies heavily on fossil fuels and is a long-time leader in lignite mining. In 2013, coal power plants generated around 45% of Germany's electricity production. Twelve new coal power plants were under construction or planned (11.7 GW)[25] as of May 2013. This new building activity is the result of the last investment cycle up to 2009 that was triggered by then-high clean/dark spreads in the industry. While the new builds were originally supposed to replace inefficient coal plants, they may now step in to fill the nuclear gap that will exist after final shut-downs. Not surprisingly, this compromises Germany's ability to meet the ambitious climate and energy goals it set in 2010.

The speed of the *Energiewende* has significantly changed the economics for conventional power plants. While, in 2013, electricity production from lignite reached its highest level since 1990 – providing further base-load power due to the nuclear phase-out and low CO_2 prices – gas-fired power production has been declining for the last three years due to closure or mothballing of no longer profitable gas-fired plants. In the mid-term, the mix of conventional power production depends on two factors. First, if CO_2 prices remain at their low level, the use of coal is likely to continue. Second, if gas prices remain at their relatively high levels, CCGTs will not increase their operating hours.

A coal-to-gas shift may result from a combination of these two factors. For example, CO_2 prices could arguably rise as a result of EU-ETS reform, while gas prices fall due to global LNG oversupply. However, that scenario remains highly unlikely. Instead, Germany's ongoing dependence on imports from geopolitically-uncertain areas (in 2012, 38% of German gas imports came from Russia[26]) and its lack of plans to engage in fracking, will likely see coal playing a fundamental role in the country's electricity mix for years to come, at least as a transition fuel. As carbon capture and storage (CCS) technology is not yet commercially viable,[27] this means coal emissions will remain a major challenge in Germany.

Infrastructure

3,500 km of new grid needed

the north to the rest of the country will require substantial investments, estimated between € 21-26 billion. The success of the *Energiewende* will highly depend on the speed and cost-effectiveness of the grid expansion.

Germany's power grid is characterized by home-grown production structures that keep power generation relatively close to consumption sites. In the future, electricity production will increase significantly in the northern part of Germany, in particular at the sea and in coastal regions (wind). In addition, much of the country's decentralized generation, such as PV and biomass, will be fed into the grid. Interconnections with neighboring countries are also expected to increase. To address these future challenges, a 10-year grid development plan was developed in 2013, prioritizing the construction of four "energy highways" and other supporting lines. Particularly important will be the construction of north-south energy highways that can bring energy from wind power plants in the north to the south.

The total investment needed for this development is estimated between € 21-26 billion.

25 BDEW (2013)

26 BMWi (2013)

27 In May 2014 Vattenfall announced that they would totally give up CCS research after 10 years because of "challenging market conditions"

Conclusion

With its historic *Energiewende* project, Germany set long-term energy and climate goals and defined intermediate targets. These targets were set before the Fukushima accident in 2011 and therefore before Germany's decision to phase out nuclear by 2022. Nevertheless, the government decided not to adjust its objectives, but to find alternative solutions instead, particularly by further developing renewable energies and promoting energy efficiency. As a result, wind and especially PV capacities have skyrocketed during the last decade, mainly driven by the high feed-in-tariffs set out in the first versions of the EEG. The new EEG 2014 puts a flexible cap on new renewable capacities, allowing the government to better control its future development and to slow down the rapid rise of electricity prices.

Today, Germany has some of the lowest wholesale electricity prices in Europe and some of the highest retail prices, due to its energy policies.

The success or failure of the *Energiewende* will depend on different factors, which each represent a major challenge:

First, to retain public support for the project, the government has to **stabilize electricity prices** and find a solution to the unequal distribution of the burden related to the EEG apportionment.

Second, a fast and cost-effective solution for grid extension needs to be found and implemented.

Third, **Germany has to define the future role of gas (and coal) in its energy mix and work seriously on its CO_2 emissions if it wants to reach its long-term reduction targets and keep its green image**.

Fourth, **the development of cost-effective storage solutions** will be critical to balance intermittent renewable supplies and use the frequent abundance of renewables at zero marginal cost. This should be a focus of political attention, without trying to pre-determine the winning technology.

Fifth, with zero marginal cost renewables increasingly dominating the market, the country must revisit its **fundamental market design and consider different solutions that enable electricity suppliers to realize a return on their investment over the long term while balancing market supply and demand over the short term**.

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