

International perspectives →

Germany's energy transition

The Energiewende - or 'energy transformation' - is a German government plan to overhaul the country's energy use, from a system based on fossil fuels to one centred on renewables. The goal is to cut greenhouse gas emissions by at least 80% by 2050.

Germany has more wind and solar power capacity than any other European country. However, coal use and therefore greenhouse gas emissions rose slightly in 2012 and 2013, putting the country's 2020 climate change target at risk.

A long-term vision

The [Energiewende](#) concept dates back to the 1980s. [Its roots lie](#) in public opposition to nuclear power, concern over climate change, and the desire of rural communities to generate their own electricity.



Its targets, formalised in 2010, commit the government to:

- reducing emissions by 80-95% by 2050, compared with 1990
- sourcing at least 80% of electricity from renewables by 2050
- making use of energy twice as efficient by 2050.

Nuclear energy will be phased out by 2022 at the latest. The nuclear decision was originally taken by Chancellor Schröder's government in 2000, but in 2010 Chancellor Merkel's government extended the date to 2036. Just a few months later, in 2011, it [reverted to the original timeline](#) in the wake of the Fukushima disaster.

The long-term Energiewende vision centres on an electricity system dominated by renewable energy. Solar panels and wind turbines would supply much of the electricity.

Offshore wind power is beginning in earnest. Image: Andreas Fusser, Creative Commons licence

But as these generate intermittently, they would be backed up by:

- renewables that can be turned on and off, such as biomass burning and hydropower
- connections across the country, allowing power to flow from one region to another
- interconnections with other European countries, allowing imports and exports of electricity
- demand response, whereby customers run non-time-critical equipment only when supply exceeds demand and power is therefore cheap

- a network of electric cars that provides flexible electricity storage when connected to charging points
- expanding use of dedicated storage, from existing facilities based on pumping water to units using batteries or other technologies
- flexible fossil fuel-fired generators as a last resort.

Private citizens and farmers own almost half of Germany's renewable energy projects. The Energiewende has overwhelming support; 92% of Germans support renewables in general (compared with about 80% in the UK), 75% see renewables as building a secure future for their children, and 69% say the benefits of Energiewende implementation outweigh the drawbacks.

Building the renewable grid

Germany's support for renewables started more than 30 years ago. Financial support mechanisms - notably, feed-in tariffs - were put in place in the early 1990s. Renewable electricity generation more than tripled between 1999 and 2012, led by wind and solar. Solar generation increased by 44% from 2011 to 2012. Germany has installed more wind capacity than any other EU country, with Spain in second place.

In 2013, Germany generated twice as much electricity from wind as the UK, and 15 times more from solar. In the first 10 months of 2014, renewables generated about 30% of Germany's electricity – nearly twice as much as nuclear, and five times as much as gas.

Net electricity exports [pdf link] to neighbouring countries reached an all-time record in 2013 due to a surplus of power. Arguably, without consistent German support for solar power, global prices for photovoltaic panels would be much higher than they are.

The 'coal paradox'

The rise in renewables has not so far cut greenhouse gas emissions from the power sector. In general, renewables have been replacing nuclear [pdf link] – another low-carbon technology - rather than coal or gas. This is expected to change in future. Germany still generates about half of its electricity from coal, both lignite (brown coal) and hard coal. It uses more coal than any other EU country, with Poland and the UK in second and third place. Four out of the five most polluting EU coal plants are in Germany.



Lignite mines, usually located next to the power station, are economically important in some regions. Image: Tobias Mandt, Creative Commons licence

Germany's Energy Minister has [argued](#) that phasing out nuclear and coal at the same time is impossible; and as Germans oppose nuclear power more than coal and gas, nuclear will go first. But coal also has strong political support in [traditional mining regions](#).

In recent years, coal burning has advanced at the expense of gas for economic reasons. Coal is much cheaper; and the price of emitting carbon dioxide under the EU Emission Trading Scheme (EU-ETS) [is not high enough](#) to make up for the difference.

As a result, there is a danger of missing the unilateral interim target of cutting emissions by 40% from 1990 levels by 2020. The government's [recent decision](#) to abandon a planned climate levy on lignite plants, while choosing instead to mothball and later decommission some lignite power plants, could make the target even harder to reach.

Germany is set to agree a new [Climate Action Programme](#) to get emissions back on track, but some critical issues are yet to be resolved. Studies have found Germany will have to [phase out brown coal](#) as early as possible to meet its climate goals. The government had been planning – until recently – to introduce a carbon emissions levy for old power stations which would have helped achieve the country's climate target.

Ten new coal-fired power stations were due to come into operation between 2012 and 2015. Those plants result from investment decisions taken 6-8 years ago. In the same period, four more scheduled projects were postponed and 22 abandoned. Beyond those now being completed, analysts [expect](#) no further unabated coal or lignite power stations to be built for the foreseeable future.

Costs and benefits

Estimates of the cost of the Energiewende vary, according to which benefits are factored in. Some studies estimate it costing [€200bn](#) over the next [eight years](#). Critics have [questioned](#) whether the policies are being rolled out cost-effectively.

The cost of subsidies for renewables is borne by domestic consumers and small business users. Their electricity bills have [risen continuously](#) since 1998. But generation costs, mainly driven by [the rising price of fossil fuels](#), accounted for about 45% of the rise from 2000-2012. Renewable subsidies accounted for about 28%.

Because homes are in general well-insulated and Germany is a wealthy nation, Germans spend a lower proportion of their disposable income on electricity than the EU average.



The Energiewende retains substantial public support. Image: campact, Creative Commons licence

Wind and solar electricity is virtually free to produce once facilities are built. So wholesale electricity prices are among the lowest in Europe. In the long-term, investments in the energy transition can produce [net savings](#).

The next phase

As the [Climate Action Programme](#) no longer includes a carbon emissions levy for old power stations to help achieve the country's climate target, a number of other measures are now planned instead, such as energy efficient technologies in electricity and heat generation, and well as energy efficiency measures in the buildings sector, at municipal level, in industry and rail transport.

The Energiewende faces some issues as the share of renewables grows. In particular, supply and demand need to be better balanced across the country. Another [36,000km](#) of high voltage lines are needed by 2020.

Currently, Germany has to route power through [bordering countries' grids](#) to take wind power from north to south. Some countries have [threatened](#) to disconnect their power lines from Germany's on the windiest days, when German electricity flows into their grids at negligible [or even negative](#) cost. But many Germans [oppose](#) construction of new power lines.

New interconnections are being built. Under a [recent agreement with Norway](#), for example, cheap German wind and solar electricity will flow to Norway when supplies are high – when wind and sun are weak, Norway will turn on its hydropower plants and sell electricity to Germany. Similar arrangements exist with Switzerland.

[More contracts are being signed](#) with companies that agree to run non-time-critical processes only when electricity supply exceeds demand. This reduces the companies' bills and helps to balance the grid.

Germany envisages having [six million electric cars on the road](#) by 2030. When they are hooked up to recharging points, they can behave as flexible electricity storage units, with the grid charging the battery when demand is low and taking electricity from it when demand is high.

The national government and some provincial governments [are investing heavily](#) in developing stand-alone battery storage.

Even so, some flexible fossil fuel generation capacity will be needed in coming decades, and a mechanism for companies to [provide stand-by power](#) is being introduced as part of the Climate Action Programme: lignite plants in the 'strategic reserve' will receive subsidies for going on 'standby', but will be decommissioned after four years in the reserve.