GERMANY'S ENERGIEWENDE
A disaster in the making

Fritz Vahrenholt

The Global Warming Policy Foundation

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About the author

Fritz Vahrenholt was one of the founders of the environmental movement in Germany. He holds a PhD in chemistry and is Honorary Professor in the Department of Chemistry at the University of Hamburg. Since 1969 he has been a member of the Social Democratic Party. From 1976 until 1997 he served in several public positions with environmental agencies such as the Federal Environment Agency, the Hessian Ministry of Environment and as Deputy Environment Minister and Senator of the City of Hamburg. From 1998 until 2000 he was a board member of Deutsche Shell, responsible for renewables. In 2001, he founded the wind energy company REpower and was CEO of RWE's renewable energy division, Innogy, one of Europe's largest renewable energy companies. His 2012 book *The Neglected Sun* sparked a broad public discussion in Germany about the dogmatism in climate science. He is the chairman of the German Wildlife Foundation and a member of the GWPF's Academic Advisory Council.

This text is based on a presentation given at the House of Commons on 17 January 2017.

1 Introduction

In 2012, I had the pleasure of delivering the GWPF annual lecture at the Royal Society. I described the *Energiewende* of the German government – its plan to transition to a low-carbon energy supply – in the aftermath of the tsunami catastrophe at Fukushima. At that time, Germany's conservative/liberal government had decided to dismantle 19 nuclear power stations by 2022, despite them supplying nearly 30% of the country's electrical power production. They were to be replaced with renewable energy. This was, for energy experts, a daunting task: to substitute a cheap, reliable, secure electricity supply with expensive, unreliable, intermittent renewable power.

But under the influence of the IPCC circus – Copenhagen, Cancun, Doha, Bali, Lima, Durban, Paris, Marrakech – and the strong demands of German society, media and politicians, Germany's government wanted to be in the vanguard of those combatting man-made climate change. They had set the next target of the *Energiewende*: to get rid of fossil fuels in power, heating and transport as well.

Under its current decarbonization plans, Berlin aims to ultimately increase the share of renewables to between 80 and 95% of total energy supply by 2050 (Figure 1). No other country in the world is following such a radical course. China will grow their carbon dioxide emissions above today's 29% share of the global total until 2035. That is, in essence, their 'deal' with President Obama and their 'commitment' in Paris.

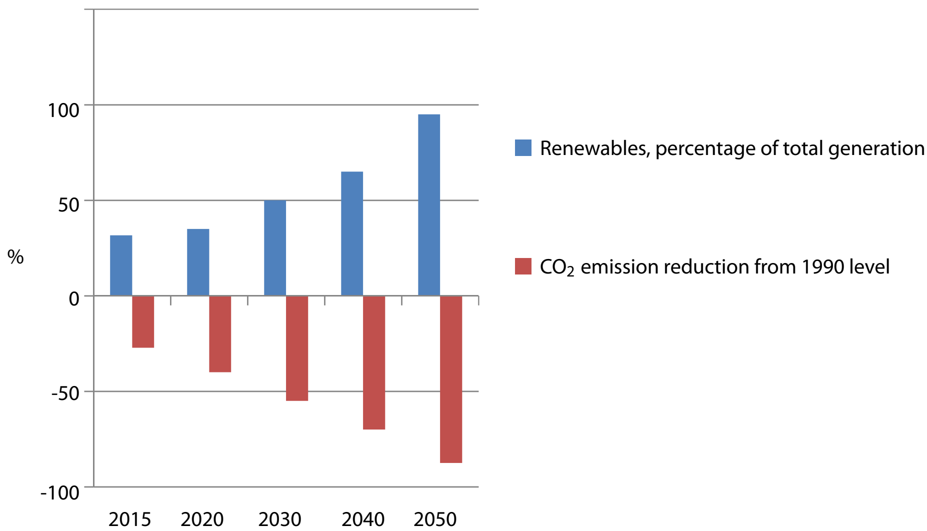


Figure 1: Germany's *Energiewende* target for 2050.
Source: Ministry of Economy and Energy, October 2016.

2 Four saving graces

In Germany, we have a proverb that you in the United Kingdom don't have. A literal translation is:

> A donkey goes onto the ice until it breaks.

Until now, the reckless policy of the *Energiewende* has avoided disaster. There are four reasons for this.

1. Lack of political opposition Although renewables are already generating an additional cost to energy consumers of the order of €25 billion annually, there is no political party in Germany that opposes the policy in the parliament; the majority of the German population support it too, because they think they are saving the world from a climate catastrophe. Today, energy prices in Germany are already the second highest in Europe (after Denmark). The additional levy on power bills for renewables will rise to an astounding 6.88 €ct/kWh in 2017, more than double the market price. (Figure 2)

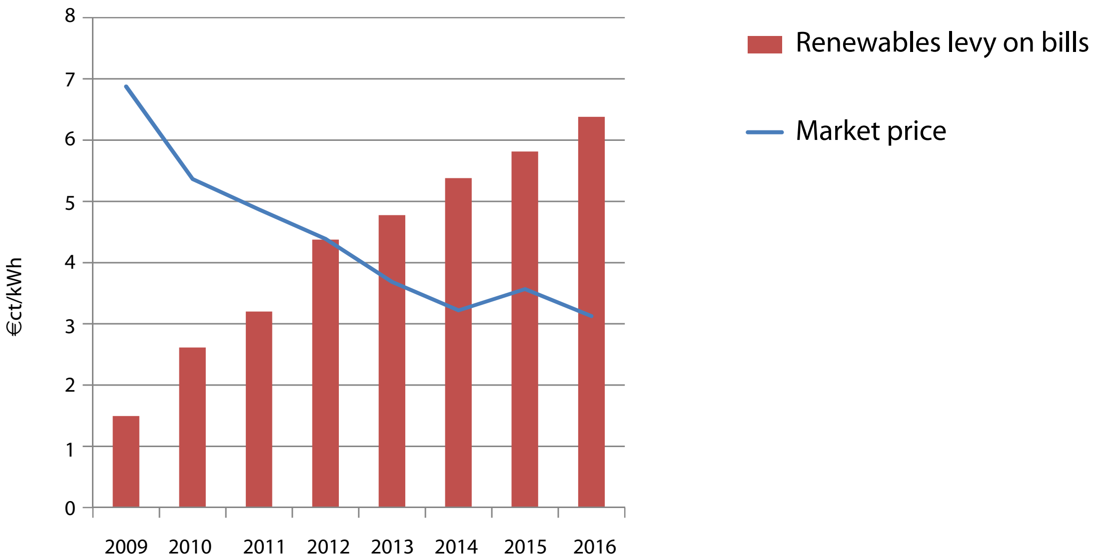


Figure 2: Decreasing power prices, increasing cost of renewables.
Source: BDEW 2016

2. Oversupply means low power prices for some Energy-intensive industries in Germany are profiting from plunging power prices on wholesale markets, the result of growing overcapacity of renewable plants. As energy-intensive industries are partially exempt from the renewables levy, industries such as steel, copper and chemicals are given a remarkable competitive advantage.

3. An over-engineered grid is a safety buffer Until now there have been no blackouts, but the risk *is* growing. The country has benefitted from typical German over-engineering of its grid, which was set up with a very wide safety margin. Even if a power line or a power station fails, the power supply remains secure, at least for now.

4. The neighbours can help Germany has nine neighbours with whom power can be exchanged. If the *Energiewende* had happened in the UK, the electricity system would have already imploded, but in Germany, on windy days, surplus power can be dumped onto the neighbours' electricity grids. During the dark doldrums – in Germany we call times when there is no wind in winter or at night the *Dunkelflaute* – we can be saved by calling on old Austrian oil-fired power stations, Polish hard-coal plants or French and Czech nuclear power.

3 Five looming problems

Nevertheless, a crisis is lurking around the corner.

Problem No 1: Intermittency

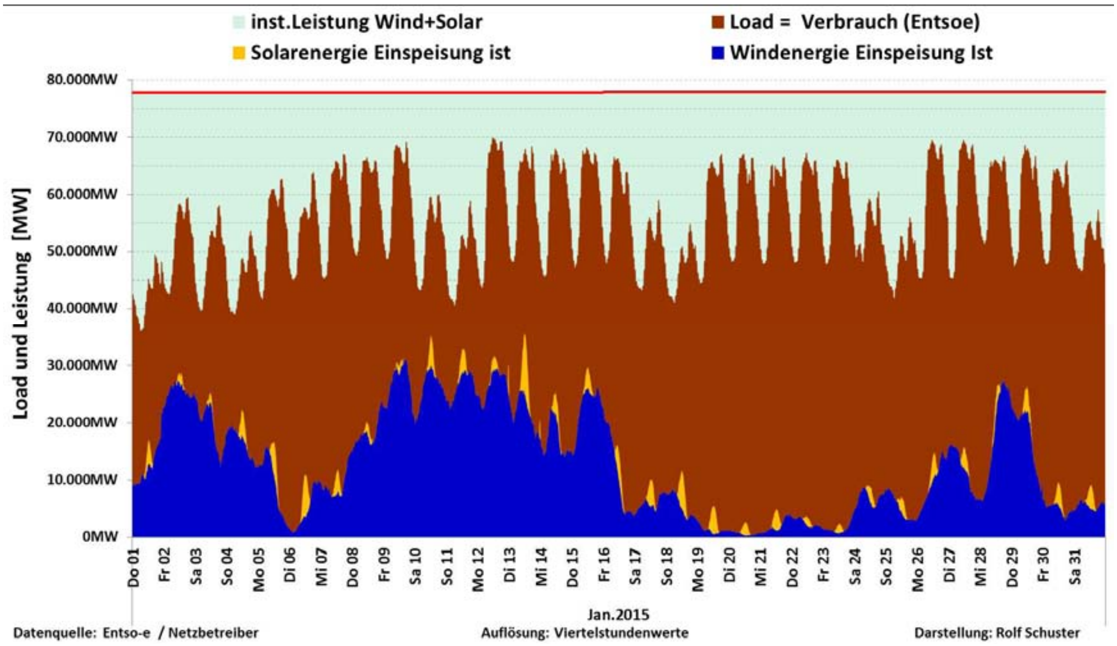
To overcome intermittency, green activists and the true believers of the mainstream tell us we have to build more capacity. However, even tripling today's wind-power capacity of 51 GW to a whopping 155 GW would not even satisfy half of Germany's power demand. But it *would* mean having a 200-m high wind turbine every 2.7 km, right across the country, no matter what the landscape, or what lakes, mountains, towns or cities were there.

But even with this huge capacity, the problem of intermittency is not solved (Figure 3). Such a system would deliver a huge oversupply when the weather was windy, but in lulls it would still deliver nothing: trebling nothing still gives you nothing. That is mathematics, not politics.

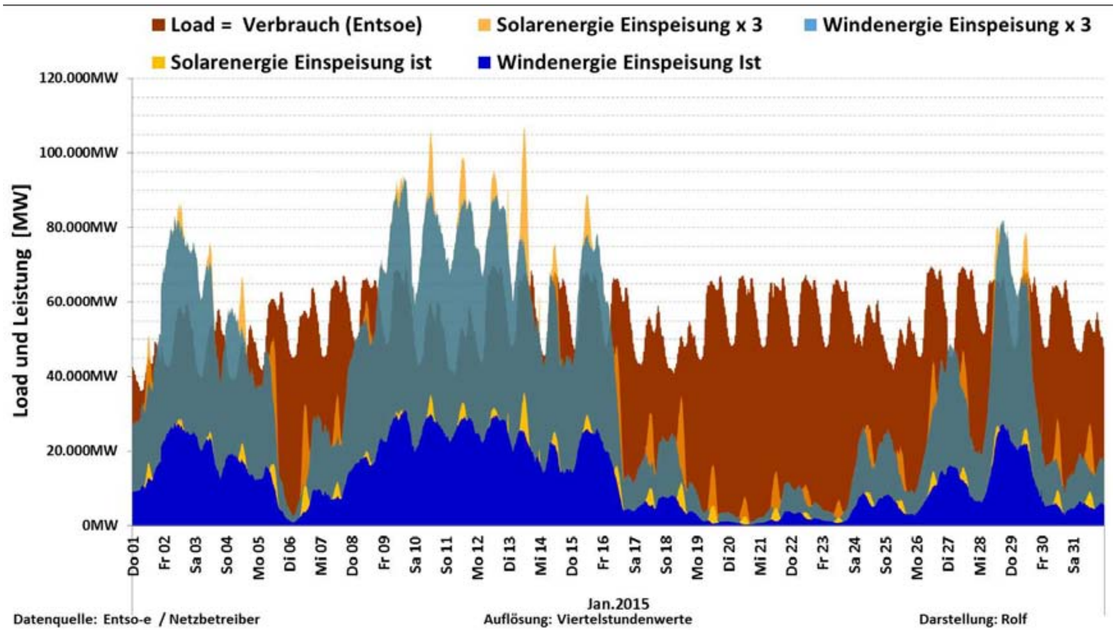
The wind not only changes from hour to hour – stronger in winter, lighter in summer – but it also changes from year to year by 25–30%. How can we cope with this silly target of 80–95% for renewables in the light of this huge interannual volatility? We can pay for a second system – a backup system of fossil fuels. That is what we are doing now, with dramatic economic consequences, and as we do the carbon dioxide target is disappearing over the horizon. Another idea is storage. I will come to that later.

Problem No 2: The grid and stability of distribution

Let us look more closely at the problem of overproduction during windy weather. The Christmas period from 24–26 December 2016 was a case in point. Germans consume



(a) Power production January 2015



(b) As above, but with tripled wind and solar capacity

Figure 3: Effect of tripling wind and solar capacity.

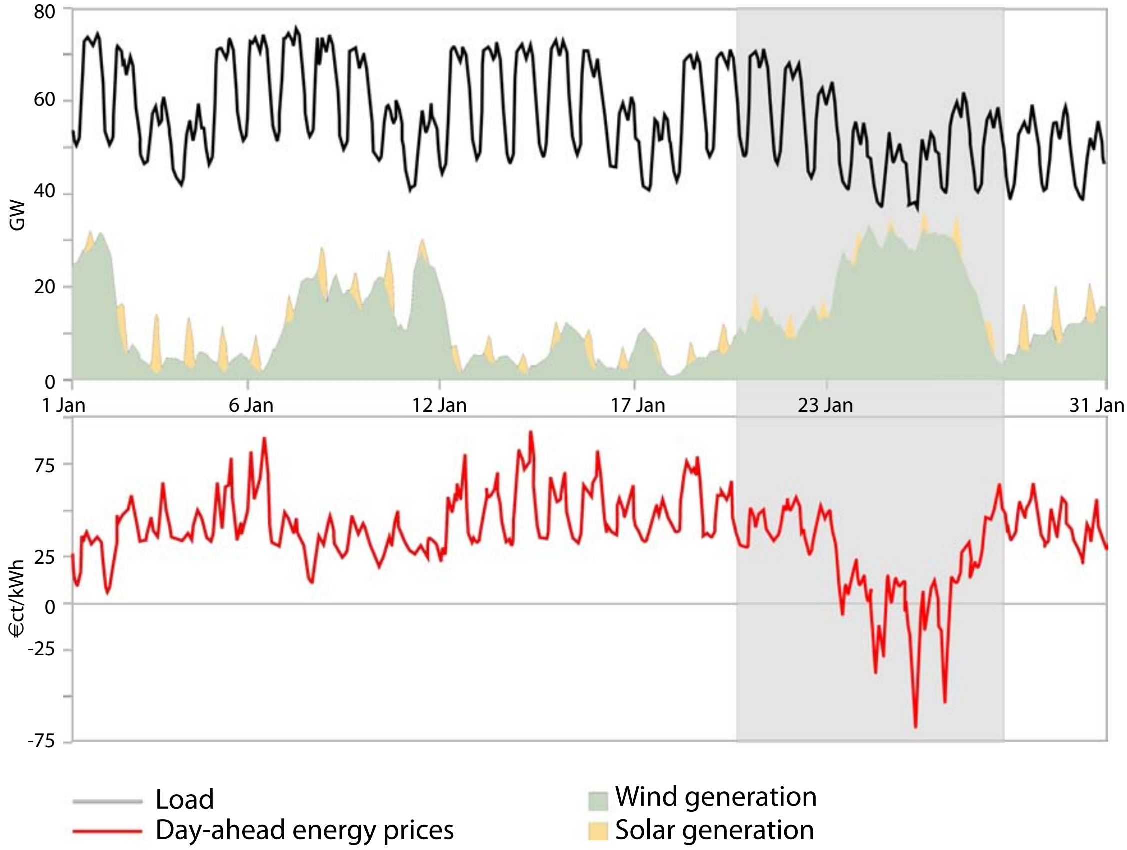


Figure 4: Load, supply and prices, Christmas 2016

Top: Load and renewables supply; bottom, day-ahead prices. In the zone shaded grey, load is falling, but renewables supply is rising, leading to a collapse in prices.

little electricity during holidays and at weekends, so when there were high winds over Christmas, there was a major problem (Figure 4). Because the law requires that renewables get priority, power utilities first throttled down the gas-fired, nuclear and coal-fired power plants. Then the first wind parks were taken offline because of the continuing oversupply to the grid. However, the windpark operators and investors were still paid under the renewables law, even though they produced nothing. The costs of such payments amount to €1 billion per year and are still rising (Figure 5). This is something one sees only in a centrally planned economy. When German vice-Chancellor Sigmar Gabriel, Minister for Economic Affairs and Energy, explained this to the Chinese energy minister, he thought it was a translation error by the interpreter. At the end, the Chinese guest stated that it would not be a good idea for China to follow suit and pay for something that had never been produced.

Yet even these payments are not enough to prevent occasional oversupply. When

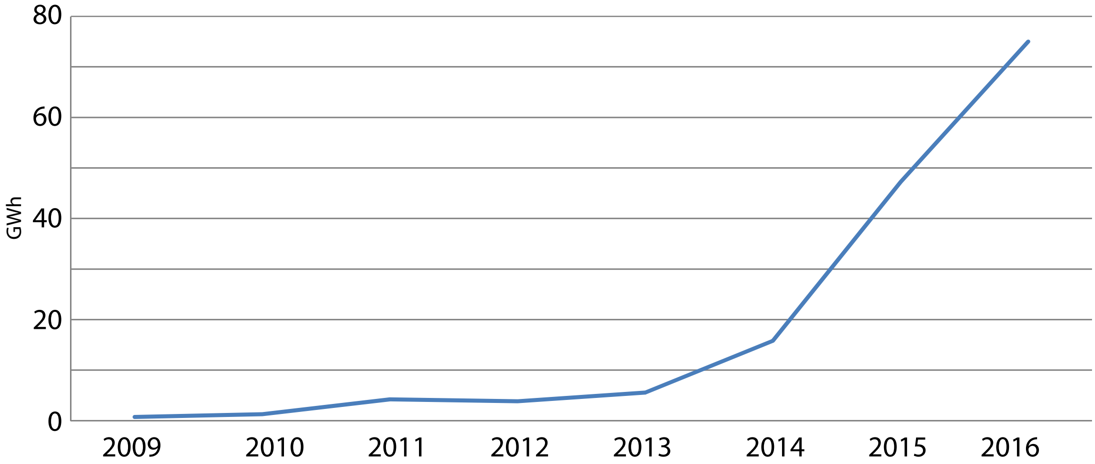


Figure 5: Discarded renewable production.
The cost in 2016 was almost €1 billion.

this happens, electricity prices actually become negative and Germany is forced to dump its excess power onto the grids of neighbouring countries. The amount of energy dumped is 50 terawatt hours (TWh) annually, out of a total wind energy generation of 85 TWh, so we are producing wind energy mainly for export.

And are the neighbours enthusiastic about receiving money for Germany's waste power? Poland, the Netherlands, Austria and Switzerland are far from thrilled, because their own power stations have to be shut down, devaluing the investments made in their manufacture. In response, Poland has obtained permission from the European Commission to build phase shifters at their border with Germany, which will repel the current from the German side. The Czech Republic will soon follow suit. Managing transborder energy flows – both of refugees and of people – is becoming a nightmare.

The proponents of renewable energy and their lobbyists, however, are still busily painting a rosy picture, claiming that oversupply incidents are the result of coal-fired power plants being allowed to continue operating. This story sounds implausible though, because wind and solar are given priority on the grid. Why don't the grid operators shut down 15–20 GW of conventional plant?

The answer lies in another problem, the so-called 'secondary reserve'. What is this? When a high-speed train leaves a station, when a steel plant is starting up or the lights go on in a football stadium, it produces a frequency change in the power grid, which automatically activates a power plant to produce more energy. There is no human intervention involved, no controller shifting a slider in a control room. It happens automatically and in just a second. However, solar and wind power cannot reliably provide such a secondary reserve. You can throttle wind down, but you cannot run it up. It is not for the love of coal that the German Grid Agency and the four power-grid operators are keeping coal-fired power plants on line. They know that without them, the power grid could collapse. The technical reality is that a minimum of 20% of electricity demand must be generated by conventional steam turbines to make the system secure.

In 2012, when the German government decided to close its nuclear plants, which were concentrated in the south of the country, the government also reshaped the grid, building huge DC cables from north to south. The wind is more abundant in the north. So the idea was to transfer wind power to the south.

A total of 6100 km of cable will have to be built by the time the last nuclear power stations shut in 2022. 400 km have been given the go-ahead and 80 km have been built, just 1.3% of the intended total. The government underestimated the opposition that their plans would meet. Building power lines on this scale has brought protests like those against nuclear power in the past. As a result, the plans for all these DC cables have been torn up and the government now plans to build them underground, increasing the cost eightfold. This has never been attempted on such a scale, anywhere in the world, and the project will probably only be completed five years after the last nuclear power station has shut down. This is not a good way to attract investors to build new facilities in the south of Germany. Interventions in the market are piling up. To safeguard a stable 50 Hz frequency in a system where intermittent wind can change the feed by 10 GW within minutes, you have to 'redispatch'. This means that grid operators have to interfere in delivery contracts between power plants and customers, ordering conventional plants to shut down if they are located at the wrong place from a grid-management perspective. Alternatively, they can give cash incen-

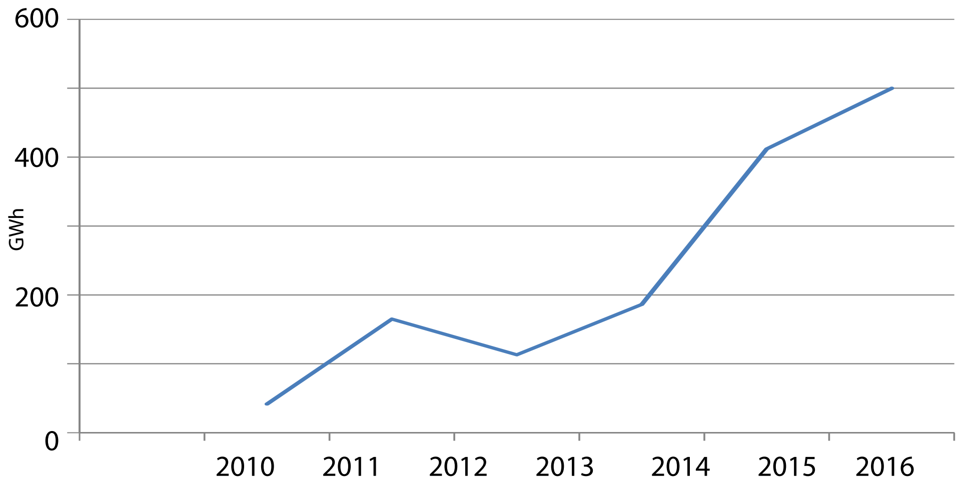


Figure 6: Redispatches in response to grid problems.
The cost in 2016 was around €500 million.

tives to generators who are too expensive but are in the right place. In 2011, before the nuclear exit and the renewables boom, grid operators had to intervene on average once a day. By 2016, this had risen to 17 times a day; 6000 interventions per year, at a cost of €500 million (Figure 6).

Problem No 3: Market distortion

If you look at power production in Germany over the last decade, you can see a shift from nuclear to renewables, a slight reduction in gas, and lignite stable (Figure 7). What is the consequence if you bring together a fixed-price system for renewables, with a 35% share of supply, and an energy market for the remaining 65%?

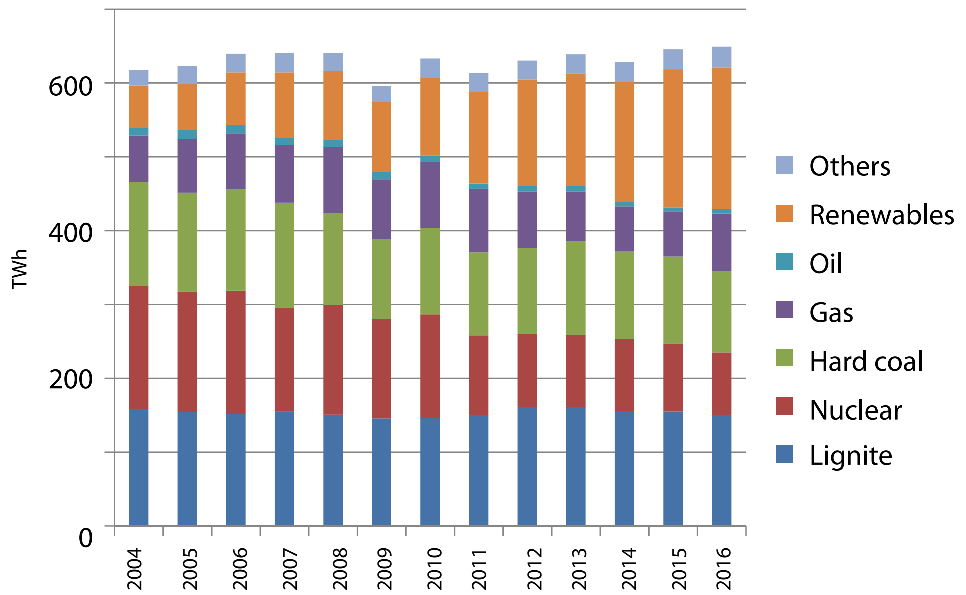
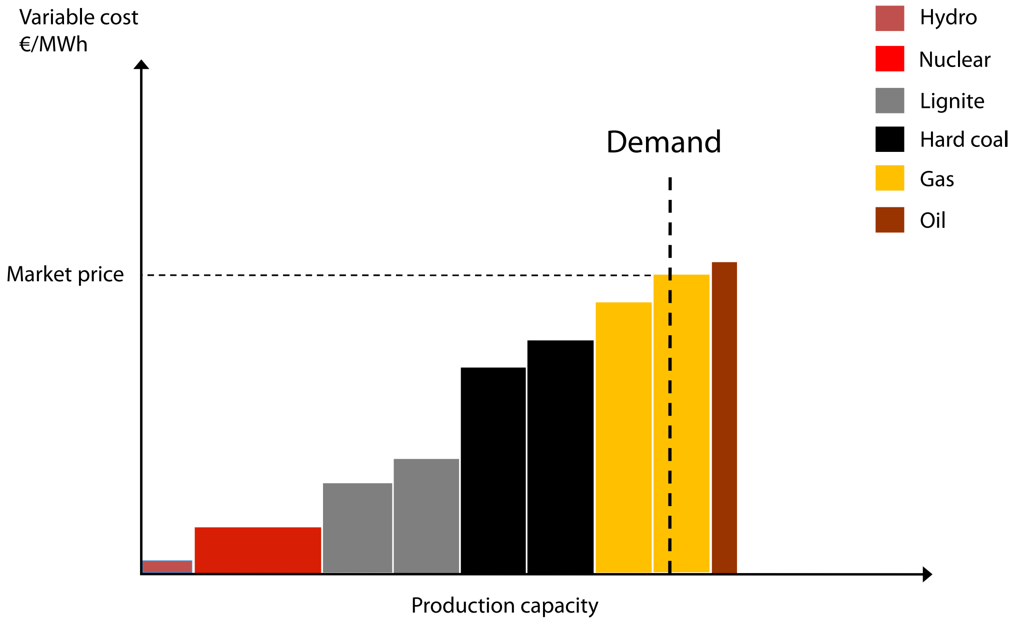


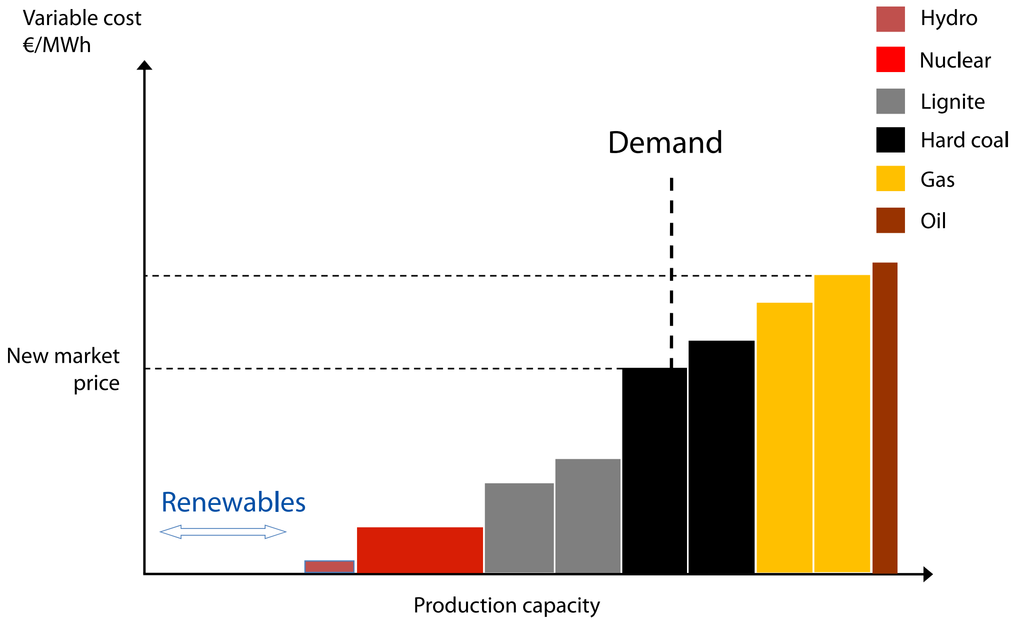
Figure 7: German energy generation mix, 2004–2016.
Source: Ministry of Economy and Energy, 2016

The market price is set by the most expensive power plant that is needed to satisfy demand. You can see the so-called 'merit order' in Figure 8a. If you now introduce renewables that have already been paid for by a fixed feed-in-tariff system and have priority on the grid, then you shift the merit order to the right (Figure 8b) and the most expensive plants are pushed out of the market. Because of this, many flexible gas-fired plants are operating in the red. Even brand new gas-fired plants are being mothballed.

The same fate has been suffered by many hard coal plants. In total, 69 power plants with a capacity of 12 GW are currently running at a loss. Besides the fact that



(a) Without renewables



(b) With renewables

Figure 8: Effect of renewables on market price.
With renewables given a favoured status in the market place by regulators, the equilibrium (a) shifts so that gas is forced out of the market (b), despite it being vital to the functioning of the grid.

a great deal of national wealth is being destroyed, the government has learned that closing that chunk of capacity leads to severe supply problems, especially in the south of Germany. In response, a law has been rushed through the German Parliament, requiring that permission be obtained from the federal grid agency before any power plant is closed, with a notice period of a full year also required. Six gigawatts of power stations have been allowed to close and 3 GW has been given a status of 'system relevant'. This means that the owner is required to operate the power station, but receives a price that only covers the operational costs. Capital costs and profit margins are simply ignored, just as they were in the old East Germany. It is like ordering a taxi cab, and then only paying for the fuel on the grounds that the car has already been paid for.

As in all centrally planned economies, the efforts of the planners are proving fruitless. Carbon dioxide emissions have not reduced substantially since 2011 – in 2016, they even increased – and electricity consumption has not reduced either.

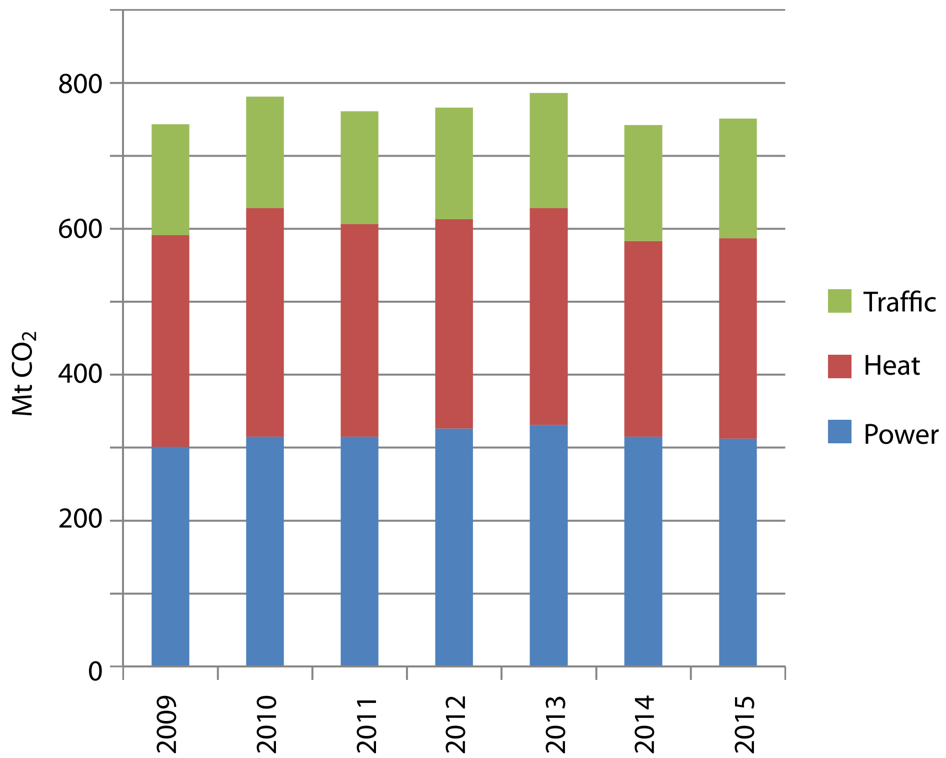


Figure 9: German carbon dioxide emissions, 2009–2015.
Source: Ministry of Economy and Energy, 2016

On a European scale, the impact of Berlin's policy is practically nil. The atmosphere has not been spared a single ton of carbon dioxide through German zeal. The system of trading emissions permits means that curbing emissions in one country leads only to permits being used in other countries. In other words, greenhouse gases are simply coming out of chimneys somewhere else in Europe.

Germany is responsible for 2.5% of global carbon dioxide emissions; China contributes 29% of the total and is adding 40 GW of coal-fired capacity each year. The total carbon dioxide emission reductions planned by the German federal government by 2020 will be wiped out by China in a mere three months. Through the steel, copper, machines, and even solar panels that they import from China, Europeans are in fact importing huge amounts of carbon dioxide emissions.

Problem No 4: Storage and 'sector coupling'

Only a dramatic expansion of a nation's energy storage capacity will resolve these nagging problems, but thus far the technologies involved have been prohibitively expensive. Today's lithium batteries cost more than €350/kWh, so with 2000 rechargings of a 50 kWh battery, the cost is 25 €ct/kWh. If, in 10 years' time we can reduce this to €100/kWh, then the storage cost will reduce to 6 €ct/kWh, but we have to bear in mind that the cost is in addition to the burden of paying for expensive solar and wind power. Building 100 GW of volatile generation capacity in the hope that in 10 years' time we will be able to store it economically seems more than a little foolish.

Using intermittent electricity to produce hydrogen by electrolysis and then forming methane (power to gas) in order to generate electricity in a gas-fired power station is an alternative, but is only economic at above 50 €ct/kWh.

Using electric cars for storage does not help much either. Even if all 40 million cars in Germany were electric, we could only store 400 GWh. But on lull days, which happen several times a year , we would need 7250 GWh.

It is a dubious strategy, but in Germany the magic words are 'sector coupling', which means that in times of shortage, we have to decide if we want to drive somewhere or have the lights on.

Problem No 5: From *Energiewende* to a disaster of biodiversity

Renewables are the most land-hungry form of energy generation. To replace the power generated by one typical coal-fired power station with renewable energy requires an area of around 500 km^2.

But it is not only wind power that needs such huge areas of land. In order to reduce carbon dioxide emissions, green policymakers, supported by the EU, installed a subsidy system for transforming maize into biogas and grain into biofuel. The result has been an ecological disaster. Turning grassland or farmland into maize or corn monocultures has led to an appalling reduction in numbers of 26 of the most important songbird species in Germany. The habitats that supply food to birds of prey have been transformed into deserts of maize. Ornithologists like the famous Dr Flade have spoken of a 'disaster of biodiversity' and he has observed that while the influence of global warming on biodiversity is hard to detect, the influence of global warming policy on it is a disaster.

Birds of prey are being sacrificed to the green ideology, as wind-farms spread into sensitive, natural areas like forests. In an elaborate field study, researchers from the University of Bielefeld came to the conclusion that the Red Kite and the Common Buzzard were now endangered. The study was commissioned by the German Energy Minister, but policy did not change. On the contrary; conservation laws will be loosened, so as to allow the killing of birds (Table 1).

Table 1: Mortality in birds of prey.

Species	Red Kite		Buzzard
Area	Brandenburg	Germany	Germany
Number of turbines (Dec 2014)	3,319	24,867	24,867
Number of casualties (Jun 2015)	65	270	332
Casualties extrapolated	165–508	>1000	11,936

In addition, 240,000 bats have been killed by wind turbines. When they fly too close to wind turbine rotors they are killed by the low pressure behind the rotors, which causes their lungs to burst.

4 Why are we planning to destroy ourselves?

You know about German *angst*. Climate priests, the media and politicians have created the illusion that carbon dioxide controls the climate. *We* are guilty, but we think that we can save the world if we simply turn the climate control knob – anthropogenic carbon dioxide – to nil.

We have forgotten that in the Medieval Warm Period, temperatures were the same or even higher without elevated levels of carbon dioxide. We have forgotten the Little Ice Age and we have suppressed the fact that the temperature increase over the last 18 years has been much lower than predicted by every climate model. The reason for this failure of the models is that the tuning of the models was based on the period from 1975 to 2000, a period in which natural influences like the Atlantic Multidecadal Oscillation warmed the northern hemisphere.

For all these reasons, resistance to the *Energiewende* has already been surfacing in Germany, although not in the federal parliament, nor in the government. Across the country, no fewer than 800 citizens' initiatives have been filed against further expansion of wind energy facilities. This movement is well organised, well informed,

Figure 10: Dead raptor at windfarm.

capable of handling conflict and, in due course, taking on the Bundestag. As they have begun to grasp the fundamental problem of the volatility of wind and solar energy, the mood of the citizens has ceased to be complacent. The urban elites' dreams of sustainable power production by wind and biogas have been realised at the cost of the loss of the homeland of the rural population.

Two possible scenarios for the years up to 2020 are conceivable:

Muddling through Policymakers might try to continue on their current course towards economic disaster. A serious move away from the *Energiewende* would amount to an admission of a strategic blunder, with unforeseeable consequences for the current political establishment. Most likely then, there will be endless corrections made to the system and increasingly bold interventions by the state as it attempts to get the flawed electricity system back under control. In the end, some new form of state energy management can be expected – an inefficient arrangement, which will be expensive and detrimental to growth.

Policy correction Over the longer term, a policy correction is feasible, but only if certain conditions are met: a failure of average global temperatures to rise as dramatically as predicted, a sense among the public of a loss of German competitiveness, and the destruction of the Germany landscape becoming a major political issue. The process will accelerate if grid failures become more frequent and supply instability increases.

But in this scenario too, there will be more state and less market in the energy business. After every blackout, the calls for more state control will become louder. The times of competitive and market-oriented energy management are probably over.

And it will take a long time to repair the serious damage caused by a misled energy policy.

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Our main focus is to analyse global warming policies and their economic and other implications. Our aim is to provide the most robust and reliable economic analysis and advice. Above all we seek to inform the media, politicians and the public, in a newsworthy way, on the subject in general and on the misinformation to which they are all too frequently being subjected at the present time.

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