The German Energiewende

A costly journey triggered by ideology and political panic but now paving the way for an essentially renewables-based power supply

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Origins, Milestones and Direction

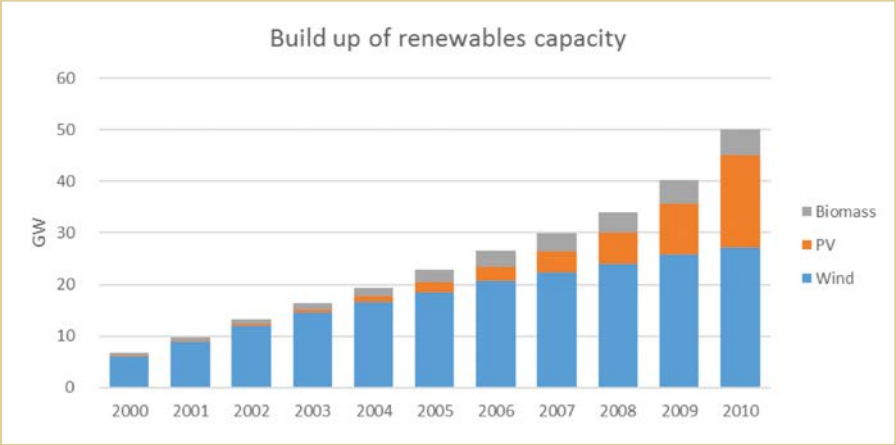
The seeds of the German Energiewende were sown way back in the late 1960s at the time when the Socialist government was starting to roll out plans for a large nuclear programme, seen then as a necessity to underpin the country's burgeoning manufacturing industry. This was also the time of student revolts and the uneasiness on the part of a small but vocal minority about this programme led eventually to the formation of the Green party. Had the government of the time taken on board the concerns of those protesters, rather than simply sending them home, it might have been possible to develop nuclear power with broader societal consent and to have avoided the fomenting undercurrents, which in time would become one of the main drivers of today's energy policy.

Influence of the Green Party

After success in various state elections, the Greens first gained influence at the federal level in a coalition with the socialists in 1998. This government introduced the first renewables energy law (EEG – Erneuerbare Energie Gesetz) in 2000, which provided for fixed feed-in tariffs for wind turbines, solar power and biofuels. Two years later the main utilities were required to sign a deal limiting the remaining output of the nuclear plants. This was a time of low fossil fuel prices, with little expectation that they would again rise to levels seen over the second oil crisis and to which they would return in only eight years. The utilities therefore expected relatively low power prices and placed a lower value on their nuclear plants than previously. The train was set in motion for renewables to progressively replace nuclear power, but little attention was given at that time to reducing greenhouse gas emissions, which a decade later would become a source of major embarrassment.

During the 2000's decade the provisions of the EEG were progressively strengthened and the plants steadily made their way onto the stage. By 2010 25 GW of PV, 29 GW of onshore wind and 6 GW of biomass plants had been commissioned (Figure 1), so that 17 % of power was generated from these non-hydro sources.

Figure 1. Build-up of renewables capacity



However, the Government's wishes for greater growth (especially in windpower) had not been met. On two different occasions (2002 and 2006) the Green Environment Minister, Jürgin Trittin, had called the utility CEOs into his office, encouraging them to invest some billions of euros in onshore windparks. To a man they refused, mainly because the FITs were not high enough for the utilities to earn their full cost of capital with the required project surcharge; in addition there were doubts over the durability of a system based so heavily upon subsidies. Instead they sunk those billions into thermal plants, on which they would neither earn their required returns, nor even (in many cases) their depreciation. This collection of decisions must in hindsight rank as one of the worst cases of corporate myopia where all the main players slept through an evolving trend and makes it hard to argue that the private sector is always better in allocating capital correctly.

PV growth and associated subsidies run completely out of control

The Energiewende began storming at the end of the decade when three years in a row some 7-8 GW of PV capacity was brought onstream as seen in Figure 2 below – a singular case of the subsidy system running completely out of control and the government doing nothing to contain the costs. As seen in Figure 3, the cost of the subsidies now amount to over €25 bn, and with other related costs have reached almost 1% of the country's GDP.

Figure 2. Annual growth in renewables capacity

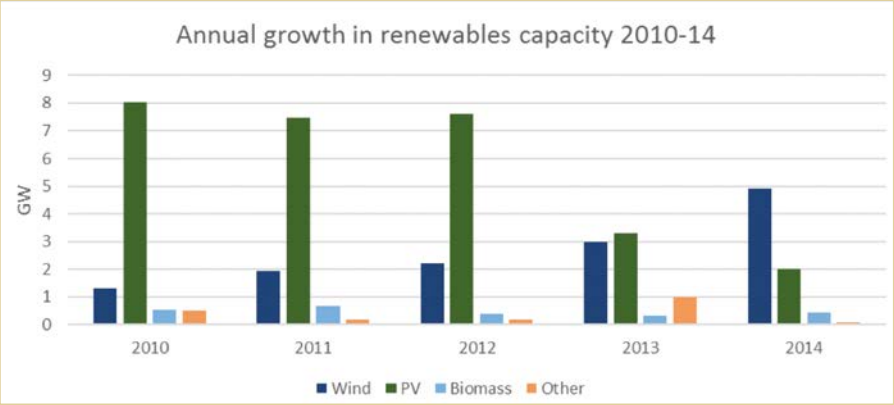
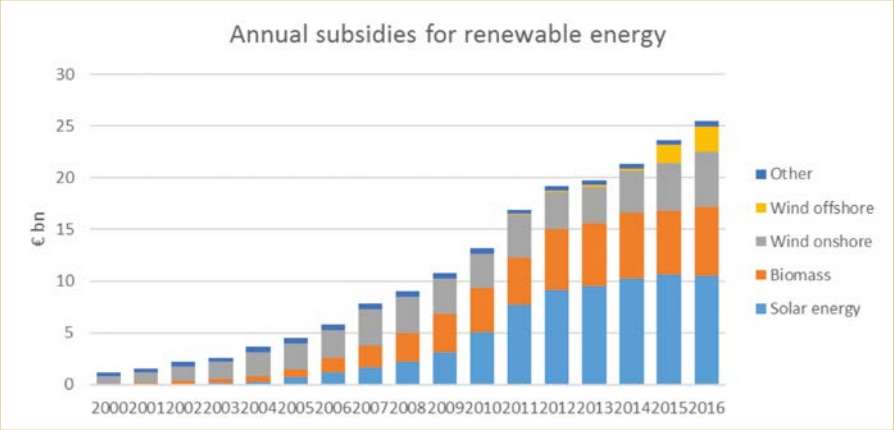


Figure 3. Annual subsidies for renewable energy



But the end of the decade also saw a change of government with the conservative-liberal coalition coming to power. Fossil fuel prices had risen strongly by now, so that nuclear power was considerably more valuable than when the utilities were forced to sign the earlier phase-out plan in 2002. The government saw the economic and environmental (in terms of greenhouse gas emissions) benefits of extending the nuclear lives and agreed to a 10-year extension plan. But as a *quid pro quo* they introduced a nuclear tax (some € 16/MWh, levied on the fuel rods) so that the taxpayer would enjoy a share of the benefits.

Fukushima and the 100-hour decision to abandon nuclear power

Hardly had the ink dried on this agreement when around the other side of the globe in Fukushima on March 11th 2011 a tsunami caused a poorly-engineered nuclear plant to melt down. The images of this catastrophe beamed across the German TV network (and possibly hyped up by the anti-nuclear media) led to mass hysteria in this country of a type which had to be experienced to be believed. And this although the incident happened thousands of kilometres away, Germany does not suffer from Tsunamis and German nuclear power stations are designed to be proof against 1-in-10,000 year incidents as compared to the 1-in-100 year Japanese standards. As just one manifestation of the panic which broke out, chemists sold out of iodine tablets (an antidote to nuclear radiation) overnight!

The government then took the "100-hour" decision, arguably the biggest decision which had been taken so quickly after a triggering event anywhere in the world in peacetime since the industrial revolution if not since the beginning of civilisation. Nuclear power had lost all support in Germany, so as an immediate gesture, the reactors which came onstream before 1980 were ordered to be disconnected from the grid forthwith. And the government also made clear, that they would take the country out of nuclear power as soon as practical. As a result part of the remaining TWh production for individual plants as agreed in 2002, was lost and led to major claims against the government.

It is indeed an important question, why the events of Fukushima had such a dramatic impact in Germany, and not in the 31 other countries with nuclear power. It is also a fair question why the Chancellor, herself a nuclear physicist, and one who should certainly have been able to understand why Fukushima could never have been repeated in Germany, lacked the courage to appear on TV and appeal for calm. But with an election looming in the important State of Baden Württemberg (which the conservative party was never going to win) her political instincts trumped her technological understanding and she realised there was no prospect of persuading her voters otherwise.

Energiewende given renewed impetus

The Energiewende was given a further boost later in 2011 when as a response to the Fukushima challenge a Government Commission set out a wide-ranging set of objectives tabulated in Table 1 with the aim of capturing the political high ground.

This group of targets could be criticised with respect to either the realism or even the necessity of certain elements, for example:

Table 1. Energiewende Targets set by Government in 2011

Targets	2020	2030
1. Phase out nuclear power by 2022		
2. CO_2 gas emissions: reduce vs. 1990 by	40%	55%
3. Renewables (RES) increase in gross final energy consumption to	18%	30%
Increase RES share in gross elec. consumption to	35%	50%
Offshore wind capacity: increase to (in GW)	10	25
4. Primary energy consumption: reduce vs. 2008 to	20%	
Electricity consumption: reduce vs.2008 by	10%	
5. Energy consumption in transport: reduce vs.2008 by	10%	
Electric vehicles: increase number to	1 mn.	6 mn.
6. Grid expansion (km.)	1855	
7. Supply security (minutes p.a. unavailability)	17	17
8. Renewables surcharge: limit to €cts 3.5/kWh		

- The aim to reduce electricity consumption itself cannot be a valid target and could even hinder long-term decarbonisation if electricity will be the cleanest form of energy

- The aim of a 40% reduction in CO_2 emissions vs. 1990 against the EU 20% target would cause Germany to load higher costs upon itself, whilst not changing even by a tonne, the total amount of emissions within the EU, let alone in the world – a totally futile aspiration.

It was the continuing growth of renewables with which the Energiewende became most strongly identified. These targets in the electricity sector were being comfortably met, with most of the others failing miserably, in particular, the expansion of the transmission grid which was so important to transport wind energy from the north of the country to fill the vacuum left by nuclear closures in the south.

A 40% CO_2 reduction target in the 2013 coalition agreement and early embarrassment with it

Come 2013 a new government coalition was elected, the conservatives this time partnering with the socialists rather than the liberals. One particular feature of the 2011 Commission Plan was firmly engrained in the Coalition contract – the 40% CO_2 reduction target, which quite quickly was going to become a major embarrassment for the government, as it stood to miss this goal by a wide margin.

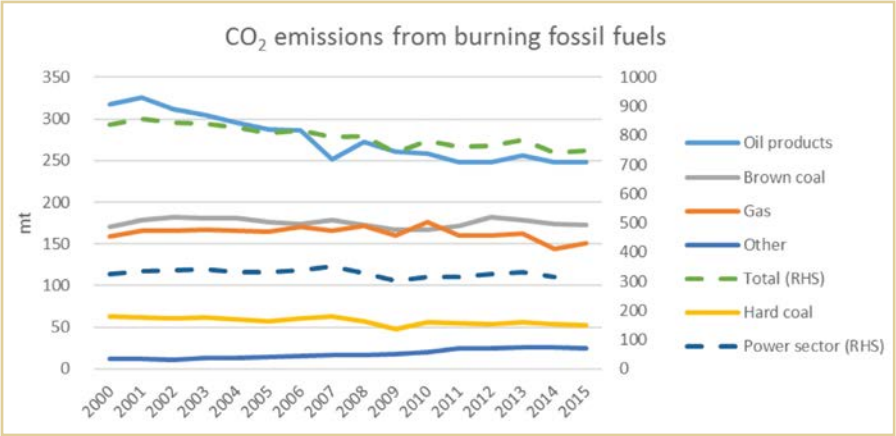
It should have been evident to all (even politicians) that it was never going to be easy to reduce CO_2 emissions during the simultaneous phase-out of nuclear power and growth of renewables, with at best the one balancing the other. Instead of declining, CO_2 emissions were actually increasing (Figure 4) – a result of the rising gap between gas and coal prices. In 2014 it was clear that Germa-

ny stood no chance of meeting its CO_2 target, so urgent action was called for.

A panic climate action plan and the threat of huge job losses

The government set out a Climate Action Plan which amongst other requirements would have led to a drastic reduction in lignite power production. But what the government did not initially understand was that, through a domino effect, their plan would lead to the entire closure of the lignite fleet. (The domino effect would work, by the fixed costs of the opencast lignite mining being loaded onto a decreasing level of lignite power production, thus driving up the variable generation costs and pushing successive tranches out of the money.) Against concerns that up to 100,000 jobs (directly and indirectly) could be lost (most likely overstated, although the losses would certainly have amounted to some tens of thousands) the unions, white-collar workers and board members of the main utilities marched on the German capital and the government quickly backed down. Instead of closing the proposed lignite capacity, some 2.7 GW of elderly plant was put in a cold reserve and the owners compensated for the fixed cash costs. (Ten days' notice would be required to activate this plant, so it is most unlikely that it could ever help alleviate a power cut.)

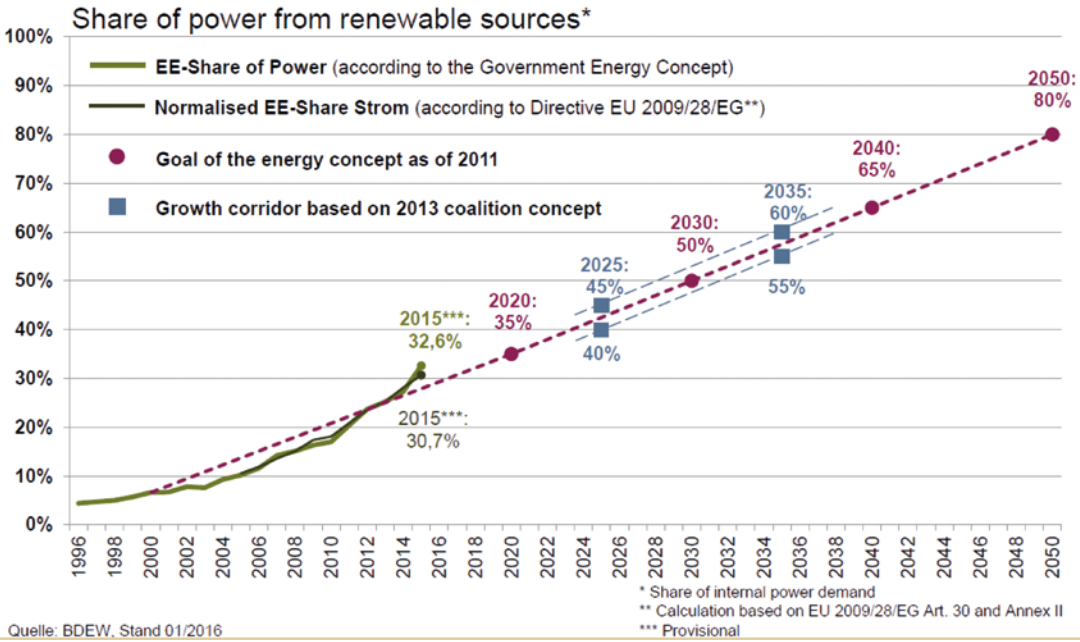
Figure 4. CO_2 Emissions from burning fossil fuels



Renewables growth continues to motor

Alongside the revised climate action plan, the government modified again the EEG to control the total costs of future renewables. The basic aim was that both PV and

Figure 5. Renewables corridor growth towards 2050 target of 80% in power



onshore wind should grow at 2.5 GW p.a. and that the level of support should be modified to achieve these aims. Partly as a requirement of the EU State Aid Guidelines (April 2014) a requirement for tendering was progressively introduced to minimise the subsidies for future plants and to apply a better market-orientated approach. Prospective developers would bid a fixed annual payment (made up from the wholesale price and a floating premium necessary to meet the agreed fixed payment) with the lowest bidder winning the tender. The target for offshore wind was reduced from 25 GW in 2030 to 15 GW, with again the tendering approach being applied.

So at time of writing towards the end of 2016 the country has only six years until nuclear power will be completely phased out, renewables power is growing steadily (in 2016 33% of power being generated from renewable sources, including conventional hydropower) and the country is well on its way to meet a renewables target of 40-45% by 2025 and 55-60% by 2025 (Figure 5).

With these two targets under control it is now coal (both lignite and hard coal) which has come into the firing line and the government is working towards a plan to phase out this source of energy. But even the greenest wing of the Government realises that it is impossible to phase out nuclear power and coal over broadly the same time scale. The Environmental Minister has prepared a draft plan, which reads very much like an electrification strategy (although this key word is missing) with the aim of a coal phase out between 2035 and 2040 at the latest. Of course, if the CO_2 price will suddenly rise in the second half of the next decade, then much of the work may already be done for her, with lignite struggling to survive.

Consequences of the Energiewende

The consequences of the Energiewende, as it has so far been running, were both difficult to foresee and have been far-reaching in their effects. Firstly, as seen in Figure 6 below the key objectives of building up renewable energy and phasing out nuclear power have been clearly met.

There are three important points to note:

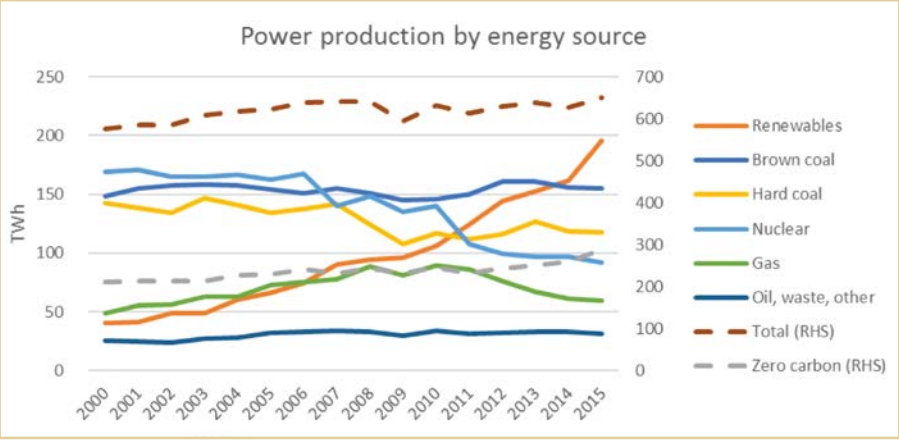
- The total zero-carbon production (nuclear plus renewables) has only risen gently as the growth in renewables marginally offset the decline in nuclear production
- Generation from gas declined significantly from 2010, whilst brown coal and hard coal generation increased. This was a direct result of the relative price movements, coal cheapening in relation to gas and also the CO_2 price remaining very low
- As a consequence, CO_2 emissions have hardly reduced

Subsidies much higher than planned

The economic consequences have been much more virulent than expected in two ways. First, the initiator of the Energiewende, Jürgin Trittin, had promised the country the transition for the price of an ice-cream per month per household (€ 60 p.a.) the cost of the subsidy to the consumers has been some 4-5 times this level. Second, the wholesale price was driven down to the floor because of the global recession, low coal prices and excess generation capacity due both to renewables and thermal plant investment decisions from around 2005.

It is instructive to look at the sum of the wholesale price and the EEG surcharge as in Figure 7 – this is effectively what most consumers are paying for the power generation part of their bill. This sum has been rising steadily till 2015 and since 2009 has been within a band which very approximately represents the full costs of the thermal and renewables plants in operation. Although the wholesale price is very low, it is the full cost of plant which consumers have to cover over the long run, and by accident rather than design, the sum of the two elements is around this level.

Figure 6. Power production by energy source



A financial disaster for utilities but substantial job creation

The combined effect of much lower wholesale prices and reduced operating hours for all thermal plants has had highly adverse consequences for the major utilities. The annual margins per MW of installed capacity of all three forms of plant (lignite, hard coal and gas) have been savagely reduced. Pure electric gas-fired plants have been virtually idle since 2012 (whereas CHP plants have continued to turn). There has been drastic loss of profits, which have led to wholesale impairments and catastrophic loss of shareholder value.

Several hundred thousand jobs have been created in the renewables sector, although the original target of half a million has been missed. At its zenith, according to one reliable source, some 380,000 jobs had been created, but this figure has been declining and in any case the quality of the average job created by almost any measure is not comparable with those in the utility industry.

The German Constitutional Court orders he Government to compensate the utilities in November 2016

Just at the time of going to press, the country's highest court offered the badly-bruised utilities a small crumb of comfort. Whilst concluding that the exit from nuclear power was in principle legal and constitutional, it ordered the government to compensate the utilities for the remaining TWh production individual nuclear plants had been agreed in 2002, but which were effectively expropriated by the precipitous political decision of March 2011. In addition, they would receive "fair" compensation for investments they made following the life-time extension agreement in 2010, only a few months earlier. The sum potentially payable is estimated at towards, or just above the €1 bn. mark. As against this the total claims (some 30 altogether) lodged by the utilities are estimated at € 19 bn. Vattenfall with its head office outside Germany can benefit from the provisions for international arbitration and is claiming € 4.7 bn. Since different legal principles will be applied in the US as compared to German courts, it is possible that the company may succeed with part or most of its claim.

It is relatively rare that a government must compensate any private company. The fact that already a hefty sum has been awarded against it, and the international arbitration case may add to this, underlines the government's overall lack of professionalism in reacting to the mass panic of five years ago.

The learning benefits from the Energiewende

There is nothing to compare with learning by doing, and although not widely appreciated, the Germans have gained remarkable experience in dispatching renewables power plants and operating grids with a high share of intermittent renewable power. These will be crucial skills which the country can export to other regions embarking on similar journeys.

Another, this time, well-documented by product of the Energiewende has been the extraordinary reduction in the costs of electricity from PV and windpower. Whilst Germany was responsible for the high quantities of capacity installed it was the manufacturing industry collectively (in the case of PV especially China) which contributed to the impressive cost reductions.

A collection of other significant side effects

Several other rather significant side effects took place which should be briefly mentioned. Firstly, there have been huge revenue transfers both between different Federal States and also different classes of citizens. Those States which have become large producers of renewable energy have earned richly from the subsidies, whereas other States which are large consumers of electricity have suffered significant outflows. Money has also flowed away from the poorer energy consumers towards some of the richer ones (over one million)

Figure 7. Development of wholesale price and EEG surcharge

who could afford to install a roof-mounted PV panel.

Secondly, Germany has become a growing exporter of electricity, both on an annual net basis and above all during hours when the country has had very high renewables generation. Although some of the neighbours have benefitted from very low cost electricity, it has often been anything but easy for them to accommodate large surges of export power into their own systems. Poland therefore installed phase-shifters on its borders to limit the level of power movements into the country.

Thirdly and very much welcomed by many, the Energiewende has led to a certain democratisation of the power supply system and a considerable loss of influence on the part of the four large utilities. So far private investors have been the single largest group of investors, followed by farmers and real estate companies, with insurance companies and the utilities themselves following closely behind.

New business models for the main utilities

The last aspect of the Energiewende which is worthy of attention is the way in which the utilities were forced to radically restructure their businesses, and the different approaches the two largest utilities – E.On and RWE - have taken.

Apart from the fact that it was clear that renewables would come to supplant all forms of power generation there were two other factors which contributed to the restructuring. First to tidy up the nuclear power legacy, there were large (and not precisely determined) liabilities both for dismantling the plants and for dealing with storage. Second, even at a global level, there was an increasing number of financial institutions who were not prepared to touch any company with coal in its footprint. This meant that it would become difficult to attract capital for investment in renewables, networks and other forms of modern energy if these would be contaminated by coal activities. A double challenge for the utilities!

Table 2. Market Capitalisation of E.On and RWE before and after the restructuring with new subsidiaries

Market Capitalisation of E.On and RWE (and their subsidiaries) before and after restructuring		
	01.09.2016	04.11.2016
E.On	€ 18.1 bn.	€ 12.7 bn.
Uniper		€ 4.7 bn.
RWE	€ 10.0 bn.	€ 8.4 bn.
innogy		€ 19.3 bn.

The two companies developed diametrically opposed solutions to these problems. E.On wanted to be rid of its nuclear liabilities and believed that by parking the nuclear plants along with other thermal plants in a subsidiary company it could (according to normal Germany company law) be clear of such on-going liabilities after five years. In addition the company wanted to avoid being kicked out of the DAX (top 30 companies by market value). It therefore initially put all the thermal and nuclear plants into a subsidiary (eventually named Uniper = Unique Performance) with renewables plants, networks and retail operations remaining in the holding company. When the government made clear that they would not accept that the holding company would avoid future nuclear liabilities after five years, E.On was forced to bring the nuclear plants into the holding company – it would have made no sense for the nuclear plants to remain in Uniper, with the ultimate liabilities remaining with the parent company, but without management control of the plants.

RWE took the reverse approach. It was the holding company where the thermal and nuclear plants (along with the trading operations) were retained. All the "modern" forms of energy – renewables, networks and retail - were put into the subsidiary "innogy" – a brand which had been established almost a decade earlier in the companies UK subsidiary. Financial institutions would be able to invest in the innogy subsidiary without dirtying their fingers with coal, and the company as a whole could attract new capital.

The verdict of the financial market on these two different approaches could not have been clearer. The table below shows the market capitalisation of the companies before and after the new constructions. In the case of E.On there was some minor shareholder value destruction, whereas the total market value of RWE became a multiple of its previous value.

The continuing direction of the Energiewende is very clear – renewables are marching on, the line will be drawn under nuclear by the end of 2022 and a plan to phase out coal is under way so that by 2040 at the latest (it could be 10 years earlier) Germany will generate almost all its power from renewable sources, with some backup from natural gas.

Relevance for other countries

A central aim of the Energiewende was that it should become a model for many, if not all, other countries to follow. Given the way in which costs ran out of control, shareholder value was wiped out and that CO_2 emissions hardly reduced, the plan has come under strong criticism from many quarters. Indeed, the US Energy Congress Committee considered it a clear example of how not to undertake an energy transition, maintaining it would never be accepted in the U.S. on overall cost grounds, and because it was funded mainly by small consumers.

Despite the efforts of the German government the Energiewende has not yet gained the international standing of a blueprint for energy of the future. Yet it has contributed enormously to the learning process in reducing radically the cost of producing renewables plants and with the manufacturers/installers of renewables plants becoming the consummate masters of renewables integration – skills which will be in great demand around the world. The success of RWE with its innogy IPO shows how a phoenix can emerge from amongst the ashes of a fossil-fuels dominated world.

The term "Energiewende" came into being in 2011 when the German government and country decided to draw a clear line under nuclear power and develop a system based primarily on renewables. The country has also excluded CCS (carbon capture and storage) even if this should eventually prove commercial and practical. Many studies into global decarbonisation believe that zero carbon emissions can only be reached only with a significant contribution from nuclear power and/or CCS. If this conclusion proves correct, then despite all the benefits arising from the Energiewende, it may not quite reach its goal of becoming the blueprint for sustainable energy with universal application, despite the very substantial contribution it has made. ■