
The *Energiewende* – Germany’s gamble

David Buchan*

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Summary

Germany has set itself a huge challenge in trying to move away from fossil fuels and abandon nuclear power, while remaining a major industrial power. This challenge to create an *Energiewende* – an energy turnaround or transformation – has ambitious targets. David Buchan argues that Germany is on track to meet only one of its three main targets (a one-third renewable share of electricity by 2020), and that the country will fail to reach the second target (to cut energy consumption by a fifth by 2020), and that this failure will make attainment of the third goal (emission reduction) harder. In a broader sense, the gamble may still come off, provided future gains in renewable technology and jobs can be achieved with lower subsidy costs. No other country can tap such technical expertise from industry or such bottom-up activism from municipal companies and citizens' cooperatives in support of low-carbon energy.

1. Introduction

Germany has set itself an extraordinary challenge in energy and climate policy – to move away from fossil fuels and simultaneously to abandon nuclear power, while remaining and growing as a major industrial economy. Germany is one of many countries striving for a low-carbon energy system, but it is unique in handicapping itself by also phasing out half of its current source of carbon-free electricity (nuclear generated power) within 10 years. How it plans to overcome this handicap, and to realise its declared hope of becoming ‘the first major industrialised nation to accomplish the transition towards a highly efficient, renewable energy system’¹, is the subject of this paper.

The challenge seemed formidable when in September 2010 Chancellor Angela Merkel’s government adopted an Energy Concept that goes beyond the national policies of other European states and European Union legislation.

Germany has assigned itself the goal of a 40 percent cut in emissions of greenhouse gases (compared with 1990) by 2020 and an 80–95 percent cut by 2050; the EU is only committed to an average 20 percent reduction by 2020 and has not agreed on any later target. For renewable energy, the country has adopted the EU-agreed goal of an 18 percent green energy share of total energy by 2020, and has also committed itself to increasing this to 60 percent by 2050, although again the EU has no agreed target beyond 2020.

Most ambitious of all is its national target for energy saving. The goal here is for primary energy consumption to fall 20 percent below 2008 levels by 2020 and 50 percent below by 2050, and, in addition, that the use of electricity should decline to 10 percent below 2008 levels by 2020 (and 25 percent below by 2050). By contrast, the general EU target is to reduce energy use by 20 percent below the expected rise if you simply project the current energy consumption trend to 2020. This is a very soft target because, if the project energy use rise is 20 percent or more, it does not amount to any absolute reduction at all.

In 2011 the task was made even harder. In the wake of the Fukushima nuclear reactor accidents in Japan in March 2011, Germany reversed its September 2010 decision to extend the life of its reactors by an average of 12 years into the mid-2030s. Instead, backed by an overwhelming parliamentary majority, the Merkel government decided never to re-start eight reactors that had been shut for servicing or repairs, and to phase out all of the other nine reactors by 2022.

Despite its lack of logic (given that German reactors are not prone to earthquakes or tsunamis), this phase-out decision was hardly a surprise. The phasing out of nuclear generation had already been decided in 2002 by the Schröder government. This decision set no precise end-date for the use of nuclear power but instead allotted a limited production volume for reactors, which, if operating continuously, would have had to cease working by around 2022. So an early exit from nuclear power had already been official policy from 2002 to 2010, until the Merkel government’s decision in September 2010 to extend the working life of reactors. The Chancellor had

¹ http://www.bmu.de/english/energy_efficiency/doc/47609.php

effectively done two U-turns in succession. But this did not leave policy totally unchanged because the reactor life extension was decided at the same time as the Energy Concept was launched and was an integral of it. As the environment ministry later admitted, nuclear power was given ‘a bridging role’ in the Energy Concept ‘until renewable energies can play their part reliably and the necessary energy infrastructure has been established’.² That bridge has been, so to speak, burned.

It would therefore have been quite understandable for the Merkel government to accompany its 2011 announcement of the eventual ending of nuclear power with a parallel easing of those Energy Concept targets whose attainment will be harder without nuclear power. Unless the carbon-free power provided by the nuclear reactors is entirely replaced by renewable energy, Germany will find it more difficult to meet its emission reduction target. Despite this, however, the Merkel government decided to stick to its earlier goals. It only added a series of measures to speed up grid expansion, market integration and investment in non-nuclear forms of generation capacity to back up renewables.

This energy revolution is often underplayed, even in Germany where people tend to say ‘nothing has really changed’, because the *atomausstieg* (nuclear exit) decision of 2011 appeared just to take them back to the policy status quo of most of the 2000s. Yet, because of the new targets enshrined in the Energy Concept, the future will be different – unless Germans no longer feel bound by official targets (which would involve a change of national character) or decide to give nuclear policy one further twist and reprieve the remaining reactors. This latter option cannot be totally ruled out, given Chancellor Merkel’s wobbly track record on nuclear policy. But it appears unlikely. Her first U-turn in favour of nuclear power was unpopular, and clearly cost her in regional elections. Her second U-turn has hardly been contested by anyone, except for the big utilities, Eon, RWE and EnBW, which own the reactors. Germany’s protracted ambiguity about nuclear power finally seemed to have resolved itself in the negative.

If many or most Germans are as nervous as ever, or more nervous than ever, about nuclear power, they also appear to be more self-confident than ever in their technical ability to do without it. The government is counting on this. ‘Our country’, argues the Federal Ministry for the Environment, Nature conservation and Nuclear Safety, ‘is a pioneer on the path towards the energy supply of the future’.³

First mover advantage. The statement above could be dismissed as political bravado. Germany, however, has already benefited from being a first mover in renewables. It rivals the US and China in deploying wind and, more especially, solar PV power. It has gained a sizeable share of the world market in these technologies, and its renewable energy industry employs 370,000 people in Germany itself. More than 20 years of subsidised support for renewables have resulted in the existence of a large number of companies (particularly among the 3,000 that belong to the VDMA engineering federation) with a strong vested interest in the continuance and even acceleration of the renewable revolution. Their voice is that of Peter Löscher, the CEO of Siemens, Europe’s largest engineering company, which recently announced

² http://www.bmu.de/english/energy_efficiency/doc/47609.php

³ *ibid.*

its withdrawal from involvement in nuclear power engineering. So, if the world market for clean energy and environmental protection goods and services continues to grow, Germany's gamble will have paid off and the the energy revolution will be the wave of the future. The German word for it, the *Energiewende* or energy turnaround, might then become as permanent a part of other languages as kindergarten, angst or schadenfreude.⁴

First mover disadvantage. Yet the *Energiewende* could also become a cautionary tale about the impossibility of making rapid transformations in energy systems. In trying to rush change, Germany could incur an offsetting 'first mover disadvantage'. To an extent, it has already incurred this disadvantage by paying very high subsidies for solar PV generation and now regretting the cost. In effect, German households have, through the renewable subsidies they pay, made the world a gift of solar technology which China has now been happy to exploit. Germany is investing, in the short term, more in coal-fired plants than in gas-fired plants (see Table 3). There is quite a lot of environmental opposition to these plants. However, if these coal-fired plants go ahead as planned, they will do so before the German public is ready to accept the fitting of carbon capture equipment that would reduce carbon pollution from these plants. Germany currently runs the risk of locking itself prematurely into more dependence on coal, before excess supply in the world gas market can exert downward pressure on the price of gas in the German market.

Energy systems not only have huge sunk costs and slow turnover in capital stock. They are also the bedrock for industry in general. Germany's energy-intensive industries are worried that the *Energiewende* – the march towards renewables and away from nuclear power – will bring higher energy costs and increased instability in the electricity supply, and thereby undermine their international competitiveness. While Europe's Emission Trading Scheme largely equalises carbon constraints on industry across the European Union, German renewable energy subsidies obviously place an extra charge on German industry alone. Germany's manufacturing sector is a massive exporter, selling abroad, for instance, 45 percent of its total 2008 turnover of €725 billion. The *Energiewende*, according to VIK, the federation of energy-intensive companies, also poses a problem of increasing interruptions and blips in the electricity supply. The country's grid operators now have to intervene more frequently to match supply and demand for a system that has become harder to balance due to the increasing number of decentralised renewable generators on it.

The impact abroad. The *atomausstieg* decision of 2011 was met with incomprehension and incredulity by Germany's pro-nuclear neighbours. While Switzerland has also decided to phase out its nuclear reactors, France, Poland and the Czech republic had assumed (as did some German utilities) that, following the 2010 reactor extension decision, Germany could again be counted on as a member, if a reluctant one, of the nuclear club. The immediate effect of the *atomausstieg* decision is that neighbouring countries all expect in the future to be exporting more power to Germany, as it becomes a net importer. They may enjoy the irony of Germany's greater reliance on French and Czech nuclear generated electricity, but they are also concerned that the change will raise electricity prices in their home markets.

⁴ Copyright for the term 'energiewende' should go to the Öko-Institut, which in 1980 published a report called 'Energiewende: Wachstum und Wohlstand ohne Erdöl und Uran' (The Energy Turnaround: Growth and Prosperity without Petroleum and Uranium).

In the longer term, however, they fear an increase in German political agitation against nearby reactors in France, the Czech republic and Poland (which shortly plans to begin building its first reactor). These countries expect agitation will grow, especially after the last German reactor closes in 2022. But the decision has already had a ripple effect in French politics. The new president, François Hollande, said during his campaign that he would seek to reduce nuclear's share of French electricity generation gradually from 75 to 50 percent and indicated that he would close France's oldest reactor at Fessenheim in Alsace on the border with Germany. He is not expected to act fast but his move is a deliberate gesture to French Green voters who have been influenced by events in Germany.

Germany's nuclear shutdown aggravates the grid spill-over problem for its neighbours. Several of the closed reactors are in southern and south-west Germany which is now more dependent on increasing amounts of wind power from northern and eastern Germany. But there is congestion on internal German transmission lines. Because electrons follow the path of least resistance, wind power has been spilling over in 'loop flows' into Poland and the Czech republic in the east and the Netherlands in the west. These countries have now placed so-called phase shifting transformers on their borders with Germany to prevent their grids being disrupted, but the problem will not go away until Germany deals with its internal transmission congestion.

More generally, it is also important for Europe that Germany gets its *Energiewende* right. The country is a large microcosm of the European Union, and all the issues tackled in the *Energiewende* are those that its EU partners will, sooner or later, have to tackle. Hence Europe's wider interest is that its pioneering member state finds an effective and affordable energy path for others to follow.

2. The ‘Energy Concept’ and the nuclear exit – scenarios and conditions

Before taking the plunge on its double decision to move towards a seriously low-carbon economy and to do so without nuclear power, the Merkel government commissioned a number of studies from various distinguished German research institutes about the costs and benefits of what it was about to do. It is beyond the scope of this paper to examine these studies in detail. These were scenarios and, in a sense, scenarios become redundant once the decision they relate to has been taken. But the general and non-redundant message of the scenarios is that, while the economic benefits of the proposed energy transformation could outweigh the costs, they are sure to do so only if certain conditions are met.

One of these conditions for sure success is a binding international climate protection agreement. A global carbon price which raises the relative cost of hydrocarbon fuels would reduce the relative cost of Germany’s increasingly renewable electricity and protect its share of world markets. The ability to reach such an agreement, however, is very largely out of German hands.

Nonetheless, other conditions – principally the efficient and cost-effective management of structural change – are within the country’s power to create. Success will obviously mean keeping costs down. This will involve trimming renewable subsidies as generation costs come down, thereby ensuring that subsidies do not give rise to windfall, and therefore wasteful, profits. It will mean avoiding the cost that comes from congestion on energy networks and from delay in the removing of bottlenecks and in expanding the grid. It will involve inventiveness in expanding electricity storage, and behavioural change which reduces demand.

In relation to international trade, the probable increase in electricity imports will have only a minor effect on so successful an exporting country whose trade balance will gain from a reduction in fossil fuel imports. The premature phase-out of nuclear power plants, however, will have a negative effect. This will come, not from the loss of the future reactor revenue that will have to be borne by the utilities and their shareholders, but from the likely rise in electricity prices. Renewables, especially intermittent wind and solar power, can drive electricity prices down, occasionally to zero. But the total system costs of renewables – to cover extra grid connections, storage, and conventional back-up subsidies – will push electricity prices higher. The scenarios generally predicted an increase in German wholesale electricity prices of 10–20 percent, due to the nuclear phase-out over the next 10 years; industry would face a 17 percent rise but there would be a smaller increase for households because they already pay a higher price than industry.

Table 1: The Energy Concept – pathways and goals

	today	2020	2030	2040	2050
Reduction in greenhouse gas emissions (base year: 1990)	- 27 %	- 40 %	- 55 %	- 70 %	- 80 %
Share of renewable energies in total final energy consumption	10 %	18 %	30 %	45 %	60 %
Share of renewable energies in electricity consumption	16 %	35 %	50 %	65 %	80 %
Reduction of primary energy consumption (base year: 2008)	- 5 %	- 20 %			- 50 %
Reduction of electricity consumption (base year: 2008)	- 1 %	- 10 %			- 25 %
Reduction of final energy consumption in the transport sector (base year: 2008)		- 10 %			- 40 %

Source: Ministry of Economics and Technology.

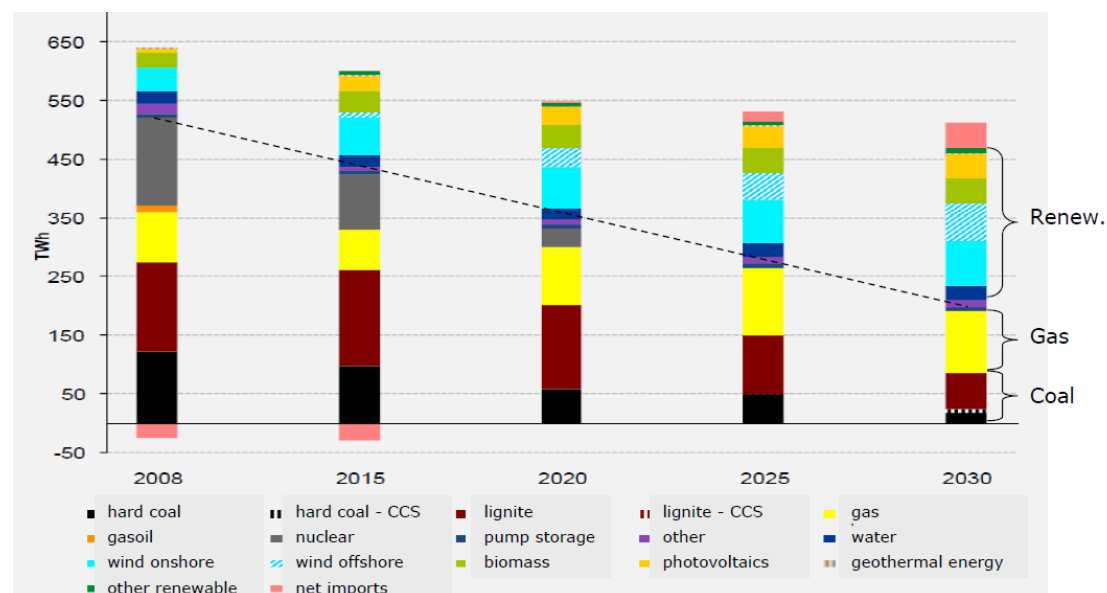
There are also some major pre-conditions to realising the Energy Concept, which are embedded in the Concept itself (see table above). These are the goals or rather aspirations since no major economy has ever achieved them: that Germany can, in less than 40 years, reduce its energy consumption by half, its electricity use by a quarter, and its use of energy in transport by 40 percent. If the population can achieve these goals, then the other goals of emission reduction and renewable increase will be much easier to achieve.

Indeed, if these energy-reduction assumptions are accepted, Germany is further along the road to meeting its other Energy Concept goals than is generally realised. For example, the present level of renewable electricity (around 123 TWh or 20 percent of the total 2011 generation of 614.5 TWh, as shown in Figure 3). If today's level of electricity consumption, approximately equal to generation, was 25 percent lower (the aim for 2050), then the present renewable share of electricity consumption would be about 26 percent, rather than 20 percent. Such a situation would also mean that the emission reduction target would also be easier to achieve.

Some sceptics about the *Energiewende* claim that these energy-reducing goals or assumptions amount to tricks, designed to give credence to the other targets, rather in the way that finance ministers project exaggerated growth forecasts in order to minimise the need for deficit or borrowing reduction measures. *Energiewende* enthusiasts would call the energy-reduction targets ambitious, but still feasible, goals to strive for. Only time will tell who is right. What everyone can agree on is that the future is likely to be harder and that some of the special circumstances leading to recent improvements in carbon and energy intensity cannot be repeated. The progress in emission reductions since 1990 was largely largely accounted for by the collapse of the former east Germany's energy-inefficient heavy industry. As Chancellor Merkel remarked in a recent speech on the *Energiewende*, 'we cannot have [the carbon reduction benefit of] German reunification again'.

Spending a lot of money to subsidy a small output of renewables is an expensive, and so far not very effective, way of lowering carbon emissions. In a 2012 report McKinsey forecast that, even with faster implementation of existing measures, Germany will only bring its greenhouse gas emissions to 31 percent below 1990 levels by 2020, rather than the goal of a 40 percent reduction. At the same time its renewable subsidies will rise from €13.5bn a year to €15bn a year by 2020.⁵ It is therefore very important not only to focus on demand-reducing measures, as McKinsey urges, but also to manage as smoothly and efficiently as possible the replacement of nuclear power. As laid out in Figure 1, given current investment plans and government policies, this will be done by a slight increase in coal use in the short term (to 2015), in gas use in the medium term (to 2025) and by a sustained rise in renewables over the whole period and beyond.

Figure 1: Germany's changing electricity mix after the nuclear phase-out decision



Source: Prognos; Energy Research Institute, University of Köln (EWI); Ministry of Economics and Technology.

⁵ <http://www.germanenergyblog.de/?p=9317>

3. Power from the people – Germany’s decentralised energy system

The hallmark of Germany’s energy system is its considerable and growing decentralisation of ownership and operation. This phenomenon complicates the implementation of the *Energiewende* transition, especially because at the federal level in Berlin the management is split between the often warring ministries of economics and of the environment. But the growing activism of municipal energy companies (*stadtwerke*) and citizens energy cooperatives (*energiegenossenschaften*) lend political and social dynamism to the country’s energy transformation, particularly because their bottom-up actions are in tune with the federal government’s goals. This activism also means that much of the technical foundation for a decentralised low-carbon system already exists.

Generation. Electricity production is dominated by the big four large generators (themselves mostly the result of multiple mergers). These are the three predominantly German-owned utilities of Eon, RWE and EnBW with the addition of Vattenfall, the Swedish state-owned company that provides generation in the former east Germany. The first three of these own the country’s nuclear plants as well as coal and gas power plants, and their balance sheets and share prices have taken a hammering from the government’s nuclear phase-out decision and the loss of future revenue stream from the premature closure of their fully-amortised reactors. Up to now, the big four have generally played little part in developing renewables in Germany, though they have been more active abroad. A frequent comment is that the big four have so far ‘failed’ to play their part in the *Energiewende*, but now have their chance to ‘redeem’ themselves in the technically challenging area of offshore wind.

Table 2: One system, but many proprietors

Electricity generation ownership		Electricity grid ownership	
<i>Conventional power (fossil fuel and nuclear)</i>	<i>Renewables (except for pumped storage)</i>	<i>High-voltage transmission system</i>	<i>Low-voltage distribution system</i>
‘Big Four’ utilities: Eon, RWE, EnBW Vattenfall account for 80%.	Private/cooperatives own 40%; farmers, financiers and project developers each hold 10–14%; Big Four only 7%.	‘Big Four’ TSOs: TenneT, Amprion, 50Hertz, Transnetz.	Stadtwerke own more than 50% of the 860 distribution system operators

The same reticence about renewables is true of the roughly 350 *stadtwerke* which generate around 10 percent of German electricity; there are some 900 energy *stadtwerke*, of which 860 own and run electricity distribution grids and 600 do the same in gas (there is double-counting because many DSOs do both). Three quarters of their generation is fossil-fuelled, although much of it is in energy-efficient combined heat and power (CHP); district heating from CHP is also something municipalities are well-placed to build and run. As a rule, the *stadtwerke* have been slow to switch into renewables, although, like the big private utilities, some have been bolder abroad. For instance, *Statdtwerke München* (SWM), the biggest municipal investor in wind, is a

partner of RWE in the €2bn North Wales offshore wind farm of Gwynt y Mor. The public utilities, however, are expanding their share of generation, though not as fast as in grid distribution. Since 2009 a group of North Rhine Westphalian municipal utilities have bought Steag, the fifth largest electricity company, from the Evonik industrial company, and another group of public sector utilities paid Eon €2.9bn for the Thüga holding company which itself owns shares in 100 energy and water companies.

The truly remarkable phenomenon on the generation side, however, has been the way that private citizens have put their money into renewables. As shown in Figure 2, by the end of 2010 private citizens, largely through energy cooperatives, owned 40 percent of the country's total of 53 GW installed renewable energy capacity (a figure which does not including pumped storage hydro). In addition farmers owned 11 percent and project developers 14 percent. Energy companies had a share of only 13.5 percent, mainly hydro power stations. Banks and investment funds owned 11 percent and commercial companies (mainly in the wood processing sector) 9 percent.⁶

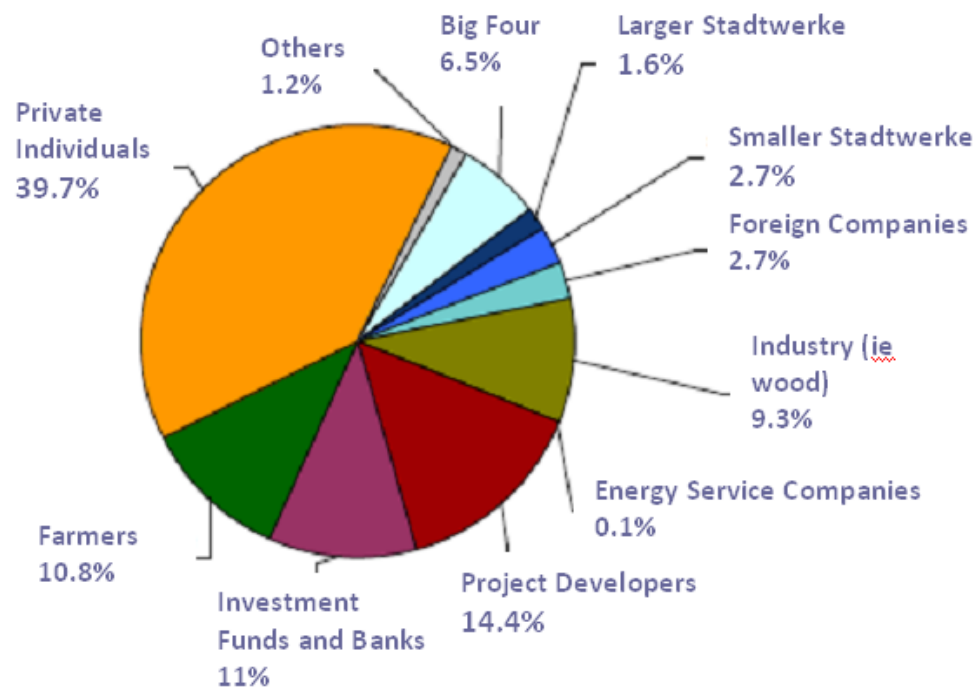
Undoubtedly, private individuals have been attracted by the certain rewards offered by feed-in tariffs, and can join a cooperative for between €100 and €500. The seeds of this 'people power' revolution, however, lie deep in the soil of German society with its long tradition of collective civic action. The tradition goes back to Germany's pre-20th century structure as a collection of city states; it showed itself in rural cooperatives that brought electricity to the countryside and it has more recent roots in the anti-nuclear movement of the 1970s and 1980s, which spawned the Greens political party.

Within the last five years, some 450 new energy cooperatives have been formed both to provide generation and run local grids. Elsewhere in Europe, interest in energy cooperatives has either waned, as in Denmark where legislation has encouraged cooperatives, but community wind farms are now seen more as investment projects for outsiders, or failed to take off, as in the UK where some government money has been available but has failed to stimulate a major cooperative movement.

There is a strong moral streak in Germany's cooperative movement, which sometimes involves Protestant Evangelical churches. The spokeswoman for the Citizens Energy Cooperative Berlin (BEB), which wants to buy the Berlin power grid, commented in April 2012 that 'the design of our future energy system is not just a matter of politics and energy, but a societal problem' – an instance of the unmistakable ethical element in the German clean energy policy. The Italian prime minister, speaking about the debt crisis, observed that 'Germans tend to regard economics as a branch of moral philosophy'; it could be added that many Germans regard clean energy policy as another branch of moral philosophy. Indeed, Chancellor Merkel explicitly linked financial debt and environmental damage when she said that 'just as we must break even with our finances, so we must [break even] with nature'.

⁶http://www.kni.de/media/pdf/Marktakteure_Erneuerbare_Energie_Anlagen_in_der_Stromerzeugung_2011.pdf

Figure 2: Ownership structure of renewable energy (except pumped storage) in 2010 (53GW)



Source: Quelle:trend:research Institut and Klaus Novy Institut, Köln.

Grid. The high-voltage grid is run by four big transmission system operators (TSOs) which used to belong to the big four generators. But financial pressure and the new EU legislation requiring greater separation of transmission from generation in the interest of fairer energy trade have obliged the generators either to sell off their transmission networks or to put them under independent management. Eon sold its network to TenneT, the Dutch state-owned TSO, RWE, sold its network to Amprion, which is owned by a consortium of investors, and Vattenfall sold its network, now called 50 Hertz, to Elia, the Belgian TSO and Macquarie, the Australian investment fund. EnBW retains ownership of its network, but it has been put under separate management and re-named TransnetBW.

These four TSOs have a very important part to play in the *Energiewende*. As grid owners and operators they are responsible for extending the grid to accommodate more renewables and for maintaining the technical stability of the system. There is some question, discussed later in this paper, as to whether all of them are up to this task. The four TSOs are also the administrative lynchpin of the renewable subsidy system. They pay renewable generators the feed-in tariff for their electricity, which they then sell on the European Energy Exchange at Leipzig and make up the difference (between the higher feed-in tariff and the lower EEX price) by collecting a renewable surcharge from consumers.

Almost all renewable electricity generation, however, is connected in the first instance to the low-voltage distribution grid. Here a surprising structural change is taking place. Germany's *stadtwerke* already own more than half the distribution grid and are

bidding for more. Local public authorities appear more and more interested in strengthening their influence in the energy sector, and in increasing their own revenues by bringing local grids, which they had leased to private operators, back under their own management. The opportunity to do this has come partly through the grid divestitures by the big energy groups and partly through the expiry of an unusually large number of grid concessions. Many of these concessions were granted at the time of reunification for 20 years and so are now expiring. According to the Association of Local Public Enterprises (VKU), which has around 800 member organisations in electricity and gas generation and distribution, 10 percent of the concessions coming up for renegotiation are being bought back by German towns and cities. In this way, a total of some 150 distribution grids have been ‘re-communalised’ in the last four years.⁷

Stadtwerke ownership carries the advantage of greater social acceptance of grid expansion. Citizens are more willing to accept the argument for more pylons and pipes if it comes from local companies and authorities rather than from a distant private utility. It is also true that a lot of low-voltage lines are buried in the ground, and therefore cause less complaint than high-voltage lines. It is not clear whether *stadtwerke* are necessarily better placed to raise the money for grid expansion. They are limited liability companies with equity capital that cannot be expanded without the dilution of municipal ownership; at the same time borrowing has become harder for everyone since the financial crisis began. Moreover, the vast majority of Germany’s 860 electricity distribution grid operators are owned by companies, whether municipal *stadtwerke* or private sector utilities, which also own electricity generation capacity; this, because it is unregulated and therefore potentially more profitable, tends to have first call on any money available for new investment.

⁷ Interview with author, May 2012.

4. Boosting renewables

The central component of the *Energiewende* is to expand renewable energy generating capacity and output. This has been achieved with extraordinary success so far. But, as the government acknowledged at the time of its June 2011 decision to end nuclear generation, ‘expansion [of renewable energy] must be cost-efficient to guarantee affordable electricity prices’, because ‘what is now a niche market must become a volume market’.

It is clear that renewable energy (and perhaps nuclear power too) needs some subsidy to overcome the innate cost and convenience advantages of fossil fuels, which traditionally have not paid any penalty for the carbon they put into the atmosphere. But how did Germany’s subsidies get so far out of line with the costs of conventional fossil fuels?

The first attempt at subsidising renewable energy was in fact more closely related to the market. In 1991 it passed the *Stromeinspeisungsgesetz* (StrEG) which literally means the law on feeding electricity into the grid and is the origin of the term ‘feed-in’ which has been adopted in the languages of the many countries which have copied this type of subsidy from Germany. The StrEG based the tariff which it guaranteed to renewable producers on the electricity market rate – not the wholesale rate but the retail rate paid by final customers. So wind energy and solar energy were paid 90 percent of the retail rate and hydroelectric plants were paid 80 percent of the retail rate. This was fairly generous, since a large part of German retail electricity rates are consumption taxes, and conventional power producers were receiving considerably less than 80–90 percent of the retail price for their electricity. Yet the StrEG tariff meant that the price offered to renewable energy producers still bore some relation to the market.

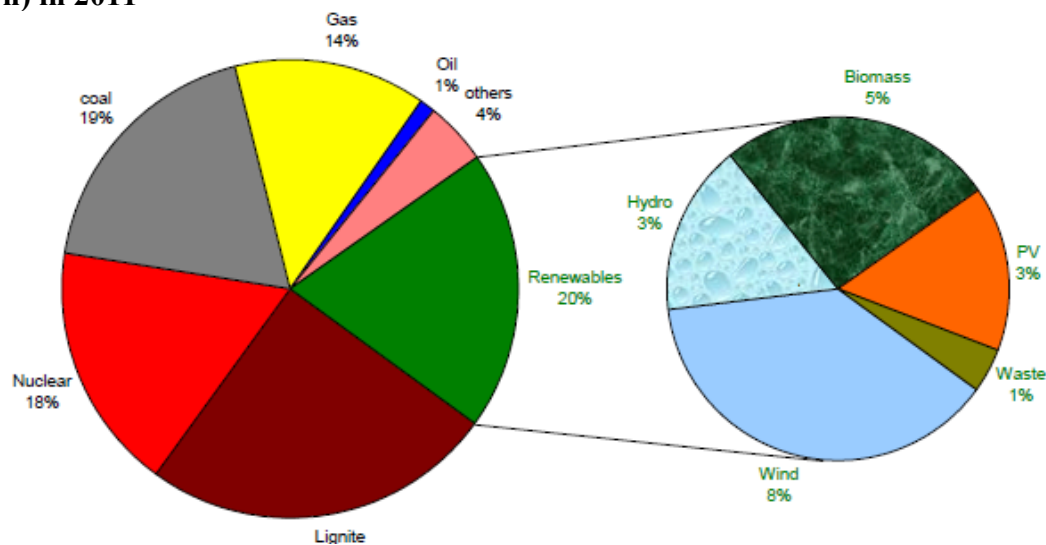
The retail price, however, had the disadvantage of fluctuating, and so did any subsidy which was tied to it. Renewable energy producers, therefore, found banks and investors less than totally enthusiastic about lending them money. In 2000, the government decided to move away from the market when calculating feed-in tariffs. A more rigid guaranteed tariff system was adopted, with the introduction of the *Erneuerbare Energien Gesetz* (EEG), the Renewable Energy Sources Act. This introduced fixed feed-in tariffs for each type of renewable energy. Not only are tariffs different for different technologies, but also within technologies tariffs differ according to project size, application and resource intensity. It is a complex system which nonetheless has the great merit for renewable operators and investors that it provides long-term certainty, unrelated to the vagaries of the market.

The tariffs are generally guaranteed for 20 years and are generally set to decrease according to a given timetable, on the assumption that renewable operators will gain experience, make technology improvements and learn-by-doing so that eventually the subsidy can be eliminated altogether. Feed-in tariffs are governed by contract law and, if the government tries unilaterally to alter tariffs on existing projects, companies can take it to court. Because of this, the German government – indeed all European governments with the partial exception of Spain – have respected the sanctity of tariff arrangements on existing contracts. So the only way governments can scale down subsidies is to reduce tariffs for new projects, as the Merkel government has sought to do in the spring of 2012 for new solar PV projects.

It is surprising that the government has not been caught out before by unanticipated decreases in technology costs, as it has been over solar PV. For the EEG feed-in tariffs are based on estimates of the cost of generation over 20 years, in addition to what is considered a reasonable profit. Even the best experts will find it hard to predict technology costs two decades ahead. At the same time, the EEG law has given renewable generators two other forms of certainty – guaranteed connection of their wind and solar farms to the grid, and guaranteed purchase of all the power they can produce.

Small wonder, therefore, that the EEG has delighted renewable operators and investors. Together, they more than tripled renewable power generation from 30 billion kWh in 1999 to over 100 billion kWh in 2010. The environment ministry claims that more than 50 countries have introduced tariff systems similar to that of the EEG, showing that Germany's renewable subsidy system itself has proved as successful an export as the wind turbines and solar technology that the system has helped to produce.

Figure 3: Renewables supply a fifth of Germany's power generation (614.5 TWh) in 2011



Source: Ministry of Economics and Technology.

Today renewable energy is a major source of investment (€23bn in 2010) and provider of jobs (employing an estimated 370,000 people in 2010). Many of the jobs have been created in relatively deprived or depressed areas and this has strengthened their political importance. The construction and installation of offshore wind turbines has created fresh work for dockyards, and many renewable energy companies have settled in eastern Germany and in the former coal mining regions of North Rhine Westphalia.

Moreover, a sizeable part of German industry now has a stake in the continuance and acceleration of renewable energy development. An executive of the VDMA, the engineering federation, estimates that the wind power sector accounts for 50,000 jobs directly and another 50,000 indirectly. 'We have only 9 manufacturers of wind turbines, such as Enercon, Siemens, Alstom, GEC, but we also have 200 makers of

components, gears, generators, bearings, pumps, fluid drive technology'.⁸ Of these companies a few, those making special steel or special tools, are dependent on the price of power and are therefore sensitive to the cost increases caused by the EEG subsidy. But electricity costs can be as low as one percent of total expenses for some engineering companies. This sector is therefore clearly in favour of the demand that the renewable energy sector provides for its engineering products.

The renewable sector's political influence is growing as a result of its pluralistic, decentralised structure. This may pose technical problems for the electricity grid but in political terms it means that supporters of green electricity – operators and constructors of wind and solar power units – can mount broad coalitions in favour of their cause. For instance in March 2012, in the face of threatened reductions in solar subsidies (to bring them into line with falling costs), the solar lobby was able to stage a protest rally (against reductions) of 11,000 people around the Brandenburg gate. Supported by opposition politicians, the rally was called by the BSW-Solar federation, together with the DBG trade union confederation, the IG-Metall steel workers, the Mining, Chemical and Energy Industrial Union and German Environmental Aid. Germany is probably one of the very few European states where the renewable lobby could bring thousands of people out on to the streets – and to some political effect. Later in March 2012 the Bundestag parliament approved sharp cuts in solar PV subsidies,⁹ only to have the Bundesrat, Germany's chamber of regions, reject the cuts in May, leaving the issue unresolved.

⁸ Interview with author, March 2012.

⁹ http://www.bmu.de/pressemitteilungen/aktuelle_pressemitteilungen/pm/48558.php

5. The ‘sweet poison’ of subsidy

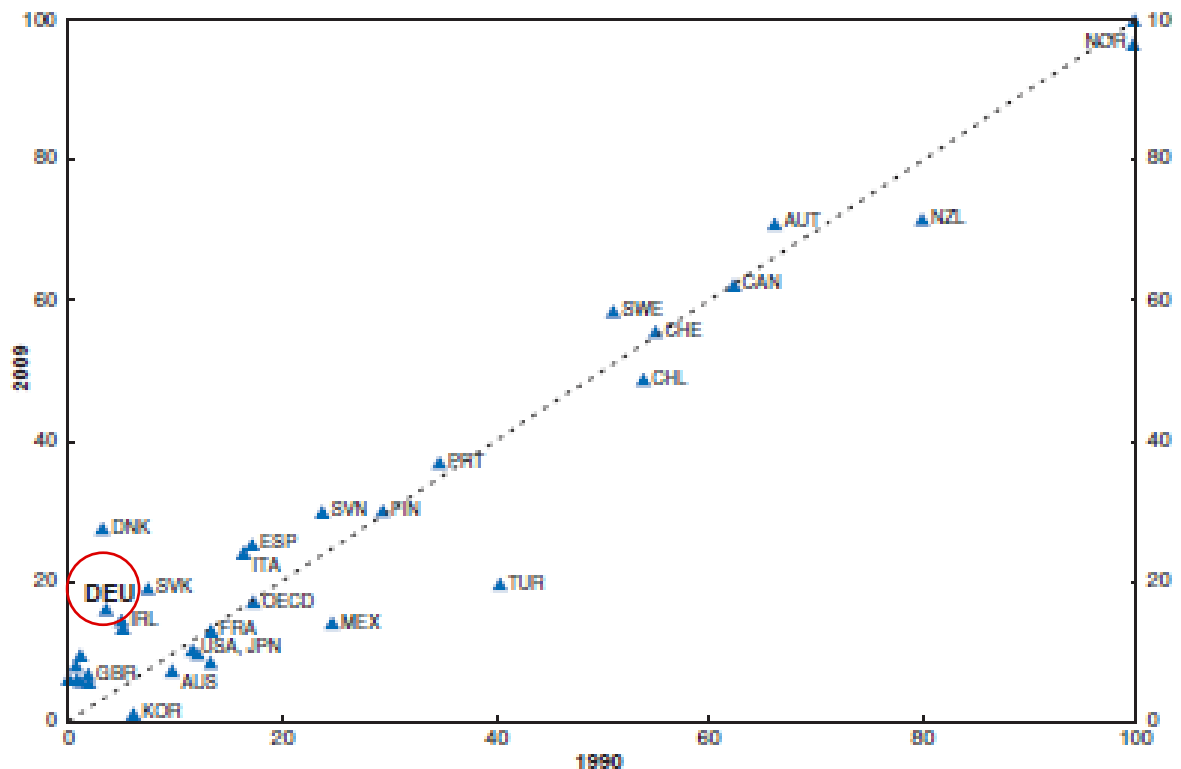
The cost of renewable subsidies is met by a surcharge on energy users’ bills, known as the EEG-Umlage. This has been rising sharply. It increased from 0.2 cents per kWh in 2000, at the outset of the EEG law, to 3.59 cents per kWh in 2012, and there is a widespread belief it will rise to 5 or more cents in 2013. The EEG-Umlage is no longer being driven up so strongly by the level or rate of feed-in tariffs for new projects. FiTs for solar PV have been notoriously high in the past, but the cuts proposed in March 2012 would put them in the 13.5–19.5 cents per kWh range. This is not much higher than the average wholesale market price for power to German households in the second half of 2011 which was 13.95 cents per kWh (although the wholesale price charged to industrial consumers with the heaviest usage was about half this rate, at 7.32 cents per kWh).

The main reason for the rising surcharge is the ever-increasing volume of renewables coming on to the system every year. In 2011 an extra 7.5GW of solar PV capacity was built, twice what had been estimated. This brought total solar PV capacity up to 24.8GW, compared with only 1.1GW in 2004.¹⁰ As a result, Philipp Rösler, the economics minister, said at the start of 2012 that it was time for Germany’s renewable industry to start weaning itself off what he called ‘the sweet poison’ of subsidy. Admittedly, Mr Rösler is a Free Democrat, a party with a pro-market tradition, and inhabits a ministry with a similar market ethos. He is, however, far from alone in believing Germany has to curb its renewable subsidy habit.

Some change is already happening. Renewable generators now have a choice, which they can revise month by month, of whether to stay with the FiT providing 100 percent of their income, or to opt for selling their power directly on to the market, with the ability to make up any loss through a market premium. So there is now some movement back towards a more market-oriented system. It has also been suggested by the Monopolies Commission supported by the Council of Economic Experts that the EEG-FiT for at least solar energy to be replaced by a quota obligation, though many Germans regard the UK’s experience with renewable quotas as showing the ineffectiveness of this alternative form of support.

¹⁰ The EEG-Umlage is not the only energy tax. Energy consumers also have to pay an ‘eco-tax’ on fuel and gas, and a share of electricity grid connection costs.

Figure 4: Shares of renewable energy sources in electricity production in 1990 and 2009



Source: OECD, *Economic Survey of Germany*, 2012.

The Bundesrat's rejection of the Bundestag-approved cuts in new solar PV tariffs temporarily leaves this cost containment effort in an uncertain state. As voted by the Bundestag, it would have cut the overall subsidy level by as much as 30 percent. In addition, it would reduce future subsidy levels by 1 percent a month, with possible increases in the reduction (up to an annual maximum cut of 29 percent) if new additions to solar PV capacity were particularly large, as they have been in the past few years.

Subsidy cuts are intended to reflect the sharp reduction in solar PV production costs, which according to the environment ministry, had fallen by more than 30 percent between late 2010 and early 2012. The sharpest decrease in production costs, however, has come in China, where massive output of PV panels, in large part stimulated by German (and other European) subsidies, has led to economies of scale and a rate of price reduction that German solar manufacturers have been unable to match. As a result, 2011–2012 saw a number of German solar companies file for bankruptcy, among them Q-Cells, once the world's largest maker of solar cells. Some observers have expressed surprise that the government has been prepared to allow this reduction in the country's solar capacity, given its claims about the first mover technology advantages stemming from the *Energiewende*. On the other hand, it could hardly bail these solar companies out, while at the same time acknowledging the wastefulness of past solar subsidies and its efforts to cut future subsidies. This situation shows how finely balanced technology pioneering can be, and how easily a first mover advantage can be transformed into a first mover disadvantage.

The government might have to take the politically more painful step of making taxpayers rather than consumers pay for renewable subsidies. This possibility is raised by the recent decision of a textile company to stop paying its EEG-Umlage on the grounds that such a levy on electricity users is unconstitutional. The company argues that because the subsidies are related to a national policy goal they should be paid out of the national budget. The company is clearly trying to get the Constitutional Court to repeat its 1994 ruling against the '*kohlepfennig*' (literally coal penny) subsidy to keep Germany's hard coal mines going. This subsidy, amounting to a lot more than a mere penny, was levied on electricity bills from 1974 on, but abolished in 1995 after the Constitutional Court ruled that electricity consumers had no special responsibility to subsidise coal for electricity. Since 1995, successive German governments have had to subsidise hard coal mining directly out of the budget, although this practice will, at the insistence of the European Commission's state aid authorities, end in 2018.

A more rational EU energy policy would replace the current system of 27 national renewable subsidy schemes, all with differing structures and levels of support, with a harmonised system of Europe-wide feed-in tariffs. Under such a uniform system, subsidy money would flow to where it could be used most efficiently; Germany might keep its predominance in wind power, but see its solar power generation shift to southern Europe. A uniform Europe-wide tariff level, however, would certainly mean lower subsidies in Germany and that could jeopardise the *Energiewende*. Of course, if renewable energy proved to be cheaper elsewhere in the EU, Germany could import it, but that would require a far better energy grid than the present one in Europe or in Germany.

6. Expanding the grid

Renewable energy imposes extra grid requirements for several reasons. First, wind power sites in particular are usually remote from centres of demand (obviously so in the case of offshore wind) and therefore require extra transport. Second, renewable energy generation is more spread out than conventional power typically generated in big coal, gas or nuclear plants; renewable energy may therefore need more transport unless it is used locally. Third, renewable energy output can replace conventional energy output, but only to the limited extent that this capacity is not needed as back-up for wind and solar power on still or cloudy days. So intermittent renewable energies like solar and wind power can never replace fossil fuels on a one-for-one basis. This is not the case with biomass, the burning of which is controllable.

Even before the *Energiewende* decision, Germany was falling well behind in matching its clean energy ambitions with the necessary grid expansion. This is an area where the organisational and technical competence of the central government and industry clash with the hard political reality of local social and environmental sensitivities, otherwise known as Nimbyism (Not In My Backyard) or Numbyism (Not Under My Backyard, in the case of objections to underground storage of carbon). Germans, in common with many other people, have been quicker to will the ends of clean energy than to will the means, such as ever taller wind turbines, fields of solar panels, and especially rows of pylons disfiguring the countryside.

Transmission grids. One of the first tasks of the Deutsche Energie Agentur (Dena), the agency set up in 2000 by the government with both public and private sector financial partners to promote renewable energy and energy efficiency, was to study the country's unmet grid needs. It concluded in 2005 that Germany needed to expand its high voltage transmission grid by another 850 kms. By 2010 only 90kms of this had been built. By that time Dena had already come out with a second study, estimating that by 2020 the country would actually need an additional 3,600 kms of high voltage line, 10 percent of the length of today's electricity transmission grid.

Even before the *atomausstieg* decision of 2011, Germany had insufficient internal transmission capacity. Nimbyist objections, along with local and court challenges, mean that it can take 8–10 years to build new transmission lines. For instance, 50Hertz, the grid operator in Germany's eastern länder, has built a line through Mecklenburg-Vorpommern that cannot be used because of an uncompleted connection in Schleswig-Holstein.

50Hertz has its own defined network area, like the other three transmission system operators (TenneT, Amprion and TransnetBW). The four TSOs need to trade power with each other for the usual technical reasons (to balance electricity supply and demand across the country). In a further complication special to Germany, they are also legally obliged to trade renewable power, because of the way the subsidy system works. This is because, in order to justify the fact that every consumer has to pay the same renewable surcharge, every consumer has to have the same proportion of renewable electricity, and of different forms of renewable energy, in their overall electricity portfolio.

Gunter Scheibner of 50Hertz acknowledges the justice of this by reference to his region of eastern Germany. ‘We have, in our region, 42 percent of the country’s total wind capacity and 30 percent of the country’s total renewable capacity. But we have only 20 percent of the country’s total electricity load [demand] in our region. So, in order that our 50Hertz customers should not pay to subsidise all this renewable power, we have to export some of it to the south and the southwest. In fact, we export 80 percent of our wind – although, for the same reason of equalising the share of renewable power nationally, we also have to import some solar power from the south’.¹¹

The big four TSOs have thus become the financial managers of the whole renewable energy system. They buy the renewable energy, at the different FiT subsidy levels, sell the power at Leipzig’s European Energy Exchange price, make up the difference by collecting the EEG-Umlage renewable surcharge from consumers, and hope that it all balances out at the end of every September. As a result, the money they manage far exceeds their turnover as grid operators; for instance, in 2011, 50Hertz had a grid operational budget of €570 million, but it managed a financial flow in renewable energy payments and subsidies of €4.4bn.

On top of this political requirement to equalise the spread of renewable energy, has come a more compelling reason to get renewable power to the big industrial areas of Baden-Wurtemberg and Bavaria in the south and southwest. It is in these areas that most of the older nuclear reactors shut down last year are located. But there are not enough transmission lines to carry wind power directly to the south. As a result, when there is a large amount of wind power coming from the North Sea and the Baltic, Germany has been using the grids of its neighbours (Poland and the Czech republic to the east, and the Netherlands to the west) to transmit some of this power. In a new form of protection – or more accurately self-protection – these neighbours have in the past year put special equipment on their borders to prevent this unwanted German power from swamping their own power. Southern Germany is also having to rely on its neighbours. During the February 2012 freeze, TenneT was unable to supply enough power from northern Germany to its southern German customers and had to call on reserves in Austria.

As Matthias Kurth said in January 2012, when he was still president of the *Bundesnetzagentur* (BnetzA) which regulates Germany’s electricity and gas networks, ‘there is a particular need for action to establish new power lines to transport wind power produced in the North and the Baltic to the centres of consumption. It must be clear to everybody that the building of new power lines is something that can in no way be avoided’.

There is some doubt as to whether all four TSOs, as currently constituted, are all equal to the formidable challenge confronting them. Until recently, there was relatively little pressure on German TSOs to expand networks, because each of them belonged to the big four energy generating groups in an oligopolistic carve-up of the market. Why would these groups encourage their TSO subsidiaries to build more regional interconnections that might have the effect of exposing their own electricity supply businesses to more competition? It was precisely to counter this psychology that the European Commission began, through legislation and anti-trust action, to

¹¹ Interview with author, March 2012.

force the groups to unbundle their TSOs and to turn them into stand-alone common carriers of energy.

In the end, Eon and RWE were happy to sell off their TSOs to reduce their debt, and it is not evident that they would be financially well-placed to invest in new transmission if they still owned the grids; nor are all the new grid owners well-placed to extend the grid. TenneT, the new owner of Eon's former grid, has special problems. It has taken over a network stretching from north to south which requires new connections for offshore wind farms and new transmission lines to the south. In November 2011 it informed the government that, while it would carry out its current commitments to connect nine wind farms in the North Sea, it could not continue this rate of connection due to the strain on its own resources and those of its suppliers as well as to delays with onshore grid planning permits.¹² To finance its German needs, TenneT can borrow on the capital markets, but it cannot raise any equity capital that would dilute its Dutch state ownership. Of course, the Dutch government and taxpayers could provide TenneT with more capital, but it is not obvious why they should do so to fund investment in Germany. Because of such difficulties, the idea has been floated, though never acted upon, of creating a single state-owned TSO for the whole of Germany.

Distribution grid. Germany's low-voltage distribution grid is of growing importance, and concern, because it is increasingly becoming the nervous system for renewable electricity. Solar PV produces low voltage electricity and therefore has to link to the distribution grid. For the moment most wind turbines are also tied to the distribution grid, though as the turbines become bigger and more powerful, up to 5 or even 10 MW, they will have to migrate to the transmission grid. According to the BnetzA's 2011 monitoring report, there is now more generating capacity connected to distribution systems (82.9 GW) than to transmission systems (77.6 GW). But much of the distribution grid will need modernising, particularly to become bi-directional in order to accommodate households selling renewable energy to the grid as well as buying from it.

Can the distribution grids shoulder this heavier load? The answer is not clear. Some are large and capable; Berlin, for instance, has just a single distribution system operator (DSO) for the whole city. But Germany has 860 electricity DSOs, some of which are very small, often *stadtwerke* owned by their local town. Distribution networks which have fewer than 100,000 customers or which are confined to their Land (state) are regulated locally rather than by the BnetzA, and therefore their capability slips below the national radar.

Planning sticks and financial carrots. The government has sought to speed grid expansion with several legislative changes. Some of these echo what was done with special legislation after German re-unification. This relaxed planning procedures and shortened judicial reviews in order to speed the integration of the two halves of the country. But this was limited in time and place (i.e. eastern Germany).

In 2009 the EnLAG Power Grid Expansion Act was passed in order to end the recurring debate that had so often impeded local planning inquiries as to whether a particular transmission line was really necessary to secure Germany's energy supplies. The EnLAG law listed 24 priority projects, for which the national need was established. Progress with these projects has been slow. In April 2011 the

¹² <http://www.germanenergyblog.de/?p=7831#more7831>

Bundesnetzagentur (BnetzA) stated in its annual report that ‘investment budgets with a total volume of around €3.9 billion had been applied for and approved for 22 out of the 24 projects named in the Power Grid Expansion Act’. A year later the incoming president of the BnetzA reported that, of 1,834 kms of transmission line needed for the 24 projects, only 214 kms had been built and of that only 100 kms was operational.

The EnLAG law still left the right to issue energy grid permits very much in the hands of the German länder. So, in 2011 the Grid Construction Acceleration Act (NABEG) was passed, by which the länder agreed to pass some powers of grid selection and approval to the BnetzA. A further streamlining of infrastructure planning may come about as a result of European legislation on energy infrastructure which the European Commission proposed in 2011 and which the Berlin government broadly supports.

For its part, the BnetzA has used its rate-setting power to increase the rate of return to TSOs and DSOs to 9 percent for new transmission lines and 7.1 percent for existing lines. The government is putting some public money into infrastructure through its public sector development bank, the KfW, which is to lend €5bn to help fund Germany’s 10 offshore wind farms; KfW has already played a part in promoting the first ones. The BnetzA has also promised to allow TSOs to recover the costs of their investment in the tariffs charged to grid customers as fast as these costs are incurred. It used to insist that TSOs wait two years to recover grid investment costs, which imposed a financial handicap especially when the TSOs were trying to increase their rate of grid building.

7. Back-up capacity

The sudden shut-down of 8 GW of nuclear capacity in 2011 has still left Germany with nearly 100 GW in generating capacity. This constitutes, for the moment, a comfortable reserve margin of at least 15GW, because peak load on the system or demand is around 82 or 83 GW. Another 10 GW of nuclear capacity will disappear by 2022, but there is about the same amount of firm capacity (in other words, fossil fuel capacity) either being built or proposed to be built over the same period. So there is no dramatic gap yet between supply and demand. How the balance of supply and demand, and therefore the need for spare capacity, evolves will depend on many factors, among them how quickly offshore wind can be developed, how cheap might gas become, whether environmental opposition blocks new coal plants, how much controllable renewable electricity can be obtained from biomass, how much electricity storage can be built, and many other imponderables.

Germany still has a certain cushion of spare generating capacity left over the pre-liberalisation era that ended in the late 1990s. Up to that point, Germany, like many other European countries, had utilities which were vertically integrated, had effective monopoly control over their operating zone and could therefore invest safe in the knowledge that they could always pass on costs to their customers. Although a certain amount of plant closed with the advent of liberalisation, there were also some special factors that encouraged the building of new plant in the 2000s. Some companies responded to incentives to build CHP plants. Others calculated that they could get free or favourable ETS permits for coal or lignite plants. This seemed to be a reasonable gamble especially after the initial 2002 decision to phase out nuclear power. This later proved to be a miscalculation when, in 2008, the EU decided that power generators in all EU countries, except for poorer ones in eastern Europe, would have to pay for their ETS permits at auction.

Table 3: More coal than gas in the short term – capacity changes in independently operated power plants, 2012–14

	2012		2013		2014	
MW capacity	Add capacity	Take out of commission	Add capacity	Take out of commission	Add capacity	Take out of commission
Brown coal	2,740	–1,960	0	–60	0	0
Hard coal	0	–1,110	4,616*	–520	2,365	0
Gas	509	–160	875	–1,037	0	–383

Source: Adapted from *Bundesnetzagentur supply report 2012*. * Excludes Eon's 1,055 MW plant at Datteln whose construction is held up by litigation.

As Table 3 shows, most of the new capacity under construction is hard coal or lignite, and relatively little is gas (although figures about new coal/lignite plants, even those under construction, should be treated with some caution because of the environmental opposition and litigation against them). Unfortunately, it appears most unlikely that any of this hard or soft coal capacity will have carbon capture and storage attached to it. The German parliament is deadlocked over legislation implementing the EU

directive setting out a legal framework for CCS; the Bundestag has approved it, but the Bundesrat has blocked it. Vattenfall has abandoned Germany's only CCS project, and there seems no likelihood of others. 'CCS is economically as well as politically dead in Germany', according to Claudia Kemfert of the DIW Institute in Berlin: 'it would need a CO₂ price of €40 or €50 a tonne of carbon to make it economic'.¹³

In environmental terms, gas would of course be a far better alternative as back-up for renewables, especially in the highly flexible and efficient form provided by Combined Cycle Gas Turbines (CCGT). Heiko Lohmann, a gas industry expert, however, explains that gas has been given no explicit role in the *Energiewende*: 'Germany has always been more of a coal country, and has always given coal relatively gentle treatment. For instance, lignite will continue to be used in the east of the country even after hard coal mining ends in 2018, because it does not require a subsidy'.¹⁴ 'Even though Germany is a major gas consumer, gas is used more for heat, being considered too valuable for power generation'. Technically, gas would be ideal as flexible back-up for renewables. But, as Thomas Birr, a vice president of RWE, recently told an energy conference, 'technical requirements do not translate into price signals that would incentivise building new gas-fired plants'. Part of the reason is the gas price. The price of Russian gas in the German market, and that of other pipeline gas suppliers such as Norway and the Netherlands, is almost entirely indexed to oil product prices and so reflects the high world price of crude oil. The major German gas importers have taken Gazprom to arbitration to break or modify the oil indexation link, but, until they succeed, gas looks less competitive as a back-up for Germany's renewables than dirty coal. Gazprom, however, has itself long been interested in getting into gas-fired power generation in Germany and has been talking to the Bavarian government about this possibility. As for shale gas, some exploration is underway in Germany, but it is too early to tell whether unconventional gas could usefully supplement Germany's dwindling production of conventional gas deposits.

The other problem for gas in the German market is one shared with coal. In the 'merit order' of electricity generation and dispatch, both fuels follow wind and solar power. In the electricity context, merit means cheap in operating terms, with the cheapest source of generation being used first. National German and EU rules give wind and solar power priority whenever they are generating electricity, not only because these sources of power cannot be controlled but also because they have very low short-run marginal costs. Therefore, renewables tend, in Germany as everywhere else, to push higher priced electricity down the merit order, reducing the amount of higher priced electricity that grid operators need to buy to meet demand. Proponents of the *Energiewende* might welcome this, because higher priced electricity is likely to be fossil-fuelled. But if this capacity becomes effectively excluded from the merit order altogether, or is never in practice called by grid operators to generate, it will never earn a financial return and may, therefore, wither away.

Indeed, the financial returns may already be evaporating for more modern conventional plant in Germany. Older generating plants built in the pre-liberalisation era, including the nuclear reactors, make a profit because they are living off the legacy of fully amortised costs. This is why Eon and RWE were so angry at having their

¹³ Interview with author, March 2012.

¹⁴ Interview with author, May 2012.

reactors shut down or curtailed. In the view of one energy company economist, most of Germany's post-liberalisation conventional plants are already today no longer able to cover their costs which are not yet fully amortised. This gives little incentive to build more conventional plant.

So the debate has begun about possible ways of subsidising back-up capacity for the country's ever-expanding renewables. For its part, the economics ministry commissioned a 2012 report from the EWI institute in Cologne. Among other conclusions, it found that demand-side management would be insufficient, and established the need for some kind of capacity support, possibly reliability contracts. According to two of the authors, however, while it is important for Germany to start studying alternative means of capacity support, there is no immediate urgency to create such support because 'there will probably be no scarcity of capacity until the early 2020s'.¹⁵

Ironically, one reason why Berlin is addressing the capacity issue is that Paris has decided to launch its own national back-up capacity scheme; yet this French move stems from concern that because of Germany's *atomausstieg* decision, France may no longer be able to rely on importing German electricity to meet French winter peak demand.

¹⁵ Presentation by Prof. Felix Höffler and Dr Christian Growitsch to OIES, May 2012.

8. Security through storage

If there is insufficient generation back-up for Germany's booming renewables, there are other ways of trying to keep electricity supply and demand in balance. A new means of doing this will come through smart grids and meters, enabling consumers to respond to price incentives to tailor use of their appliances to available supply. In the main, however, Germany will rely on increasing storage of electricity, developing means to absorb any surplus power and to deliver it when needed. Again, there will be new ways of doing this.

Two of them are storage of electricity as compressed air in underground caverns, and as hydrogen, which can be made out of water and electricity by means of electrolysis, and then reconverted into electricity using fuel cells, gas turbines or gas-powered engines. This power-to-hydrogen conversion is being very seriously studied, not least because the country's 443,000 kms of gas pipeline could provide ample potential storage for the hydrogen, according to Jan Ulland of the BDEW energy federation.¹⁶ Adding just two percent of hydrogen to the natural gas does not alter the nature of the gas, say experts, though anything more could require re-engineering of turbines.

But the main increase in storage is likely to be in the traditional form of hydro-electricity from pumped storage plants. These PSPs use surplus or cheap electricity to pump water from a lower reservoir to a higher reservoir, which then releases the water to make hydroelectricity when power is in short supply or expensive. Germany has around 30 of these PSPs. They account for 95 percent of total German storage, and represent 6.3GW of storage output and 40GWh of storage capacity. The government is trying to encourage the building of more PSPs by exempting those that start operation before 2019 from grid use charges for a period of 10 years. A recent Deutsche Bank study estimated that by 2025, with these incentives, PSP output capacity in Germany could be raised to a total of 10.6 GW and storage capacity to 64 GWh.¹⁷ In addition, Germany is likely to rely more on the hydroelectric storage, fed by pumps or natural river flow, of its neighbours – Austria and Switzerland in the south and Norway and Sweden in the north.

But such are the likely volumes of German wind and solar power that will need to be evened out and matched to demand that other, more novel, forms of pumped storage are being considered by a very traditional supplier of energy in Germany – RAG AG, formerly Ruhrkohle AG.

All the German coal mines, many of which once belonged to individual steel companies such as Krupp, Thyssen and Hoesch, were amalgamated in RAG in 1969 in order to create an orderly run-down of the industry. RAG, which employed 500,000 coal miners in 1969, now has 20,000 miners working in five mines. One is to close in 2012 and the other four by 2018, under an agreement with the European Commission on the final phasing out of coal subsidies in that year.

But RAG is now trying to use its residual resources and facilities spread over 20,000 hectares to re-invent itself as a renewable energy company: it has installed tall wind

¹⁶ Interview with author, March 2012.

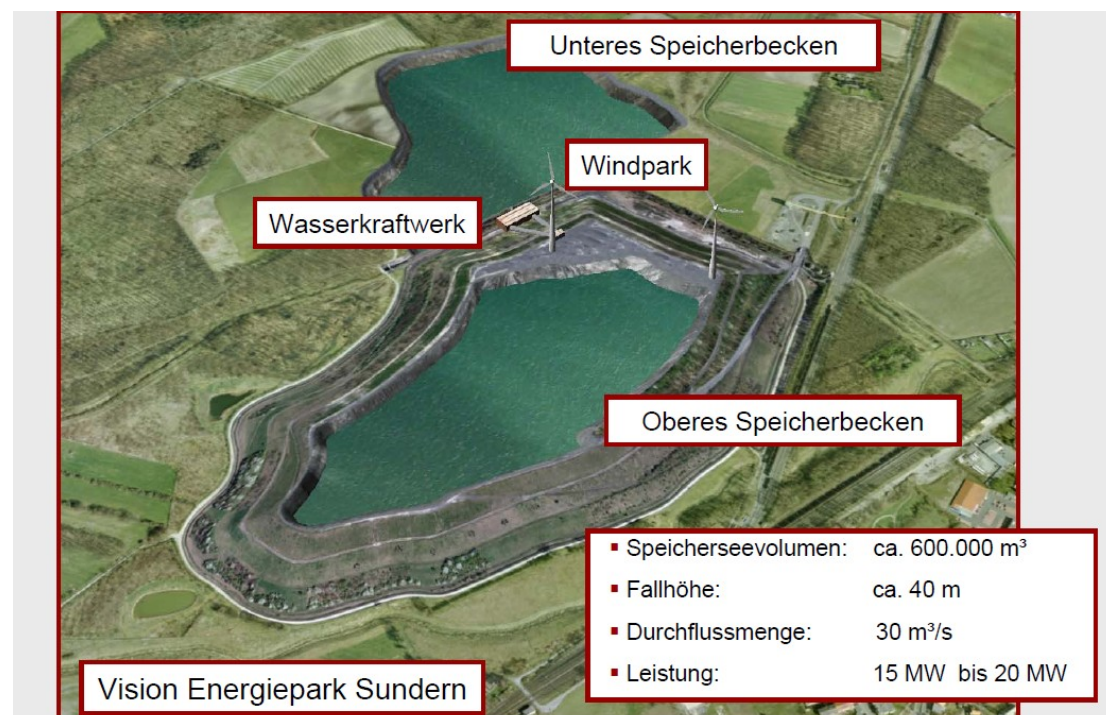
¹⁷ State of the art electricity storage systems, Deutsche Bank, March 8 2012.

turbines on some of its slag heaps; it has put solar panels on old coal blending sheds; and it plans to start pumping up from the mines naturally warm water of around 30 degrees centigrade to provide geo-thermal heat for schools.

It is also experimenting with pumped storage in two novel ways. One is a feasibility study RAG is carrying out with RWE to see if, in the flat Ruhr landscape, an artificial lake can be created 50 metres up on top of a slag heap, with a lower reservoir and a hydroelectric turbine in between. Gernot Pahlen of RAG says the main questions the study needs to answer is whether a 50 metre fall is enough, and how much water can the upper reservoir hold without destabilising the slag heap. The two questions are inter-related. In producing hydroelectricity, the higher the fall of the water, the smaller the volume of water needed, and vice versa.

Exactly the same trade-off applies to RAG's other pumped storage project which would involve pouring water, from an artificial lake at the top of its Prosper-Haniel mine in the Ruhr, straight down a 1 kilometre vertical mine shaft and through a turbine at the bottom. This turbine could generate up to 300 MWh of power, though there is a question about how to get the electricity up to the surface. The biggest problem, says Walter Eilert of RAG, is how to build a big enough box for the water at the bottom of the mine shaft, which would be pumped back to the surface when power is cheap or not needed for storage. RAG cannot use the ordinary water swilling around at the bottom of mine shafts, because this always has too much salt and would corrode turbines. So, in contrast to the slag heap PSP, this underground waterfall idea has plenty of vertical fall but may not have enough water – a conundrum RAG is studying together with the two Ruhr universities of Bochum and of Duisberg-Essen.

Figure 5: Visualisation of RAG's idea of a pumped storage reservoir on top of a slag heap

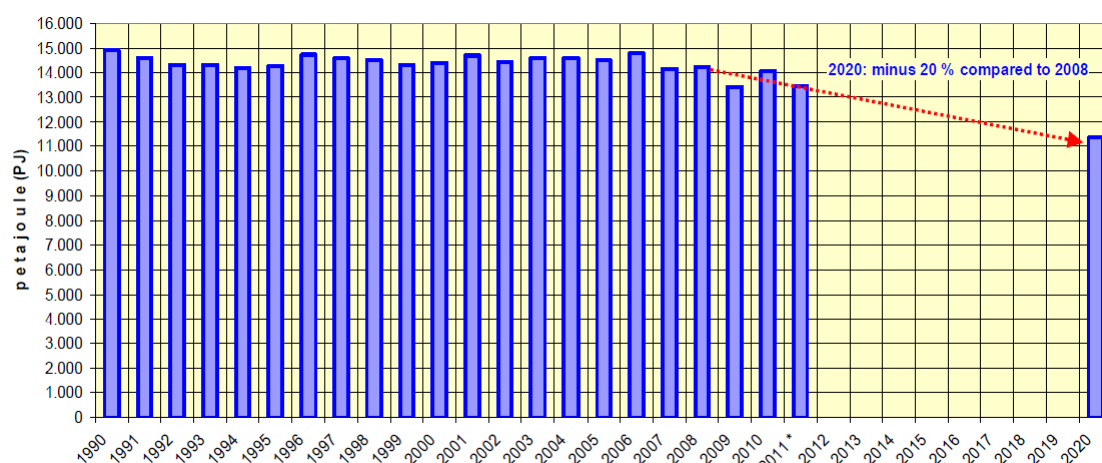


9. Energy efficiency yes, energy saving maybe not

This paper has already underlined the importance of energy saving to the attainment of the *Energiewende*'s others goals of reducing emissions and increasing the share of renewable energy. The more energy Germany saves, the lower are its emissions, and the smaller is its total energy consumption, the easier it is for renewables to reach a high percentage of this smaller total.

One of the sub-targets is to raise the growth rate of energy productivity or efficiency, measured as GDP per unit of energy, to 2.1 percent a year. This does not look too hard to achieve, given that in almost all industrialised economies generally the ratio of energy use to production is falling and given that Germans are an inventive and efficient people. Recent trends, however, suggest this may be more difficult. According to the OECD, German energy productivity improved by an average 1.7 percent a year throughout the 1990–2010 period. And according to the Odyssee energy efficiency index used by the EU, German energy efficiency improved between 1991 and 2008 by an average of only 1.4 percent a year, with the improvement tailing off in recent years.¹⁸ In the first half of this period, 1991–2000, the improvement averaged 1.7 percent a year, partly due to the dismantling of inefficient industry in east Germany, while in the 2000–2008 period the average improvement fell to only 1.1 percent, or roughly the average for the whole EU. This later performance was despite a commitment in 2002 to double energy productivity by 2020, which would have required raising the yearly average growth to 3 percent.

Figure 6: Primary energy demand – past trends and future aims



Source: Ministry of Economics and Technology.

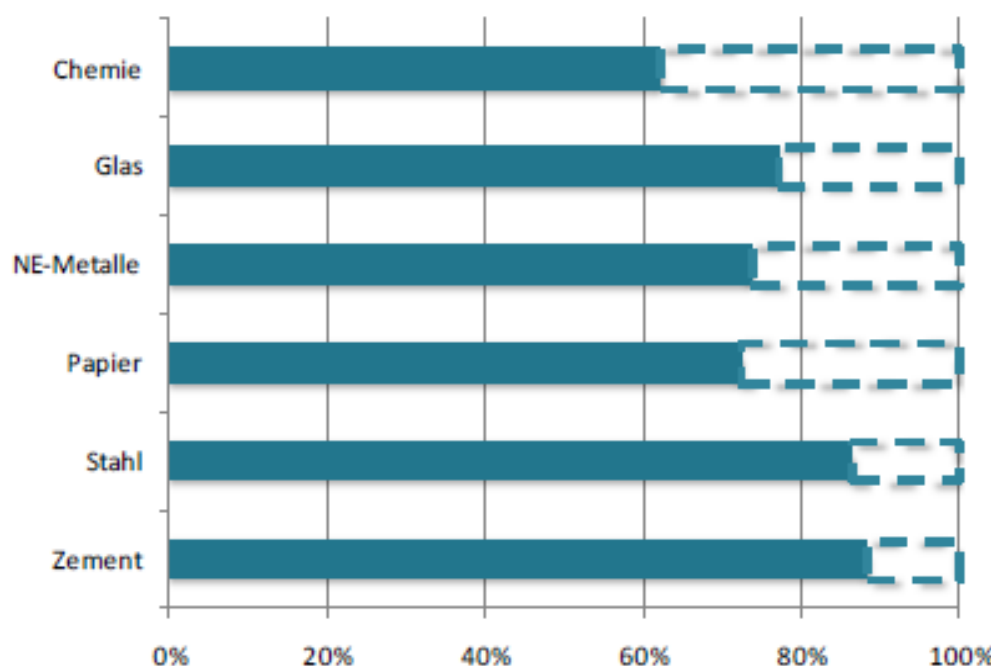
Nevertheless, raising energy efficiency would appear relatively easy, compared to cutting the absolute level of energy use. Germany's energy consumption has been broadly flat for the past two decades, as the efficiency improvements we have seen above have enabled the country to produce more goods and services for its people and world with the same amount of energy. Henceforth, though, as a result of the 2010

¹⁸ See <http://www.odyssee-indicators.org>, July 2011.

Energy Concept, Germany's primary energy consumption (mainly fossil fuels) is supposed to fall, from its 2008 level, by 20 percent by 2020 and by 50 percent by 2050. Germany is also to reduce its electricity consumption, again from the 2008 level, by 10 percent by 2020 and by 25 percent by 2050. (The differentiated reductions arise from plans to replace fossil fuels with renewably-generated electricity in, for instance, cars). These targets are an extremely tall order to fulfil, given that Germany has a stable population and an expanding economy.

Industry. Some government initiatives have been designed to persuade industry to reduce carbon emissions, and therefore energy use, voluntarily. But after the introduction in 2005 of the EU emissions trading scheme covering the main industries of Germany and its EU partners, German industry has been largely encouraged to increase energy efficiency in its own self-interest. That it has generally done a good job is shown in a study carried out by the RWI institute for the Verband der Industriellen Energie und Kraftwirtschaft or VIK, which represents some 350 energy-intensive companies across a wide range of industries with around 1million employees. Figure 7, based on this study, illustrates the improvement: the solid bars represent the sectors' energy consumption in 2008, as a percentage of their energy consumption in 1990 (1990=100 percent). Birgit Ortlieb of the VIK federation concludes that 'our companies have already tried their best to use energy more efficiently, and the low-hanging fruits have already been harvested, especially in the chemical industry.'¹⁹

Figure 7: Reduction in energy use by industry branch 1990–2008 (1990=100%)



Source: RWI study for VIK, 2010 (NE-Metalle = non-ferrous metals)

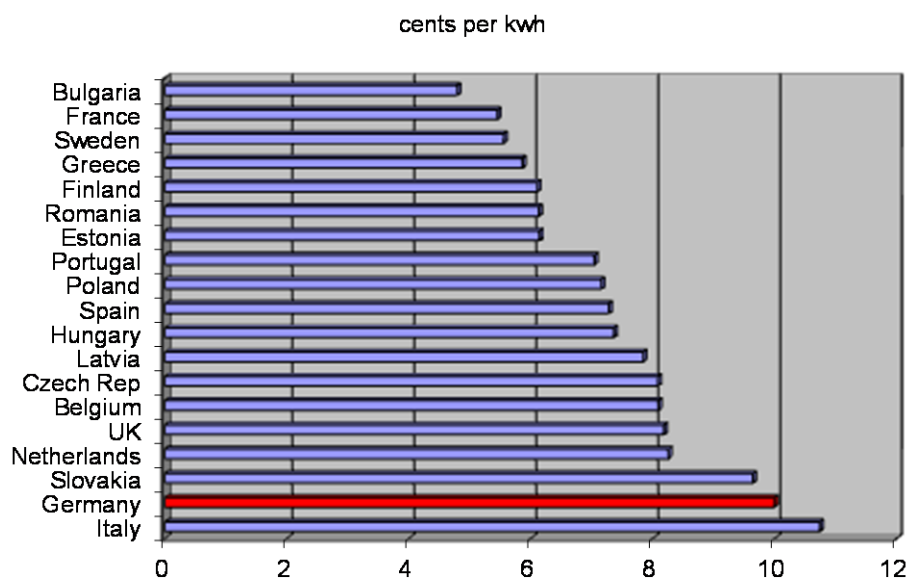
¹⁹ Interview with author, March 2012.

Given the relative difficulty of making further efficiency improvements, energy-intensive German companies are obviously nervous about their energy costs. German industry has long faced high electricity prices, partly as the consequence of a power sector that was until recently cartelised and uncompetitive and partly due to past government policies such as payment of the *kohlepfennig* subsidy to coal miners. And it has coped very well, in part because some German goods can sell around the world based on quality almost regardless of price. It may well be that it is high energy costs which have forced German industry to go for quality, just as higher petrol costs have been one factor in the greater efficiency of European and Japanese cars over American ones.

Nonetheless, German industry knows that it has to be vigilant about its energy costs, and Figure 8 illustrates why. It shows the average electricity prices paid by industry, including taxes, except for value added tax, in the second half of 2011. It is true that about 800 energy-intensive companies in Germany pay the renewable surcharge, the EEG Umlage, at a very reduced rate, as well as cheaper power compared to households which get no exemption from the renewable surcharge and pay a higher price for the electricity. However, industry as a whole is anxious about future increases in this cost surcharge, which is beginning to approach the cost of the electricity itself. For instance, if the surcharge were to rise to 5 cents per KWh, as is widely expected over the next year or so, this would start to approach the level (average of 7.32 cents per KWh in July–December 2011) of current wholesale industrial electricity prices (excluding taxes) in Germany. Furthermore, there is a prospect that electricity consumers will have to make some kind of capacity payment.

Germany's energy-intensive industries, however, along with their counterparts in other EU states, which might also be vulnerable to competition from countries outside Europe without carbon constraints, have won a big concession from the European Commission. The EU executive has agreed that governments can compensate their companies for up to 85 percent of the cost of ETS carbon allowances. Moreover, unlike many other EU governments, the Berlin government actually has the money to pay out this subsidy.

Figure 8: Average electricity prices (with taxes except for VAT) for industrial consumers using 70,000–150,000 MWh a year, July–December 2011



Source: compiled by author based on Eurostat data.

Buildings. Germany is commonly thought to have a relatively energy efficient housing stock, partly because it has in recent years pioneered some very low-energy houses such as the ‘*passivhaus*’. This impression is misleading. The rushed post-1945 reconstruction meant that many houses were built with poor material and standards, though this is not the case with the more measured post-1989 reconstruction in the eastern länder. So, although the housing stock is younger than in countries less touched by the second world war, it is still the case that 75 percent of its existing buildings were built before the country’s first thermal insulation ordinance came into force in 1979.

Germany has, however, been quick to implement EU legislation. It put the EU’s 2002 directive on energy performance in buildings into German national law in 2002, even though this directive did not have to take effect until 2006. And its building codes are now significantly tougher than standards prescribed by EU legislation. The Kreditanstalt für Wiederaufbau (KfW), which is the biggest of Europe’s national development banks, is heavily involved in the refurbishing of buildings. In 2011 the government promised to increase funding for the CO₂ Building Rehabilitation Programme from €936m in 2011 to €1.5bn a year in 2012–2014.

This is partly designed to make up the funding shortfall for energy efficiency from the Energy and Climate Fund. This fund was established with €300m in 2011 and 2012, and it was originally planned that these resources would rise sharply to €2.5bn in 2013 with the introduction of ETS allowances auctioning (assuming an ETS carbon price of €15), rising to €3bn a year by 2017, financed by tax revenue from the time-extended nuclear plants. These assumptions no longer hold. The ETS price is around €7 a tonne and the nuclear tax is contested. Germany’s länder have proved unwilling to help financially.

The government claims to be leading the way by making all new government buildings, from 2012, nearly zero-energy, and has promised to raise the proportion of houses being renovated each year from 1 to 2 percent of the total housing stock. In Brussels, however, Germany has taken a different tack. During the first half of 2012, it was among those EU countries trying to dilute a new draft EU energy efficiency law, especially its requirement that governments renovate 3 percent of their larger public buildings each year.

A number of the country's energy economists believe the government's ambitious energy saving goals are not being credibly implemented. Some 40 of them published an open letter to the government and parliament in *Die Zeit* in January 2012,²⁰ which complained that the government was putting too much trust in the auto-pilot [*selbst-lauf*] of the market to deliver energy saving goals, and not enough in regulation, supervision and cooperation with industry. In the absence of more money and regulation, Claudia Kemfert, one of the *Die Zeit* appeal signatories, has argued that the drive to insulate more houses is meeting only partial success. It is working in the cities where house prices are higher and thermal insulation appears to pay off, but it is slow in the countryside where house prices are lower and the inhabitants older.

Energy appliances. The energy appliance dearest to a German's heart is his or her car. A still-cherished freedom is the right to drive it as fast as superb German engineering will allow. Germany continues to be the only country in Europe without a universal speed limit on all its roads, to the detriment of fuel consumption and carbon pollution which increases disproportionately with speed. Partly as a result of this, and partly because German car makers have, compared to other European manufacturers, a relatively high share of heavy, powerful cars in their fleets, the country had for some years dragged its feet on EU-wide fuel and CO₂ emission standards. It agreed to new tighter European norms only reluctantly.

By contrast, on all other energy appliances Germany has pressed for higher EU efficiency standards. In particular, it has been supporting in Brussels the so-called 'top runner' approach, whereby the most efficient model of, say, boiler or washing machine is declared standard and all the other models are gradually but systematically taken off the market. In June 2011 the government said it wanted to ensure that European product standards and energy consumption labelling 'should be aligned more closely with the best available technology (top runner approach) and updated regularly'.²¹ Germany needs higher EU product standards in order for its own energy-saving policies to work at home since it cannot operate separate national standards within the single EU market. Higher EU product standards would also benefit the German exporters who are the makers many of these 'top runner' products.

²⁰ www.zeit.de/wirtschaft/2012-01/energiesparen-appell

²¹ http://www.bmu.de/english/energy_efficiency/doc/47609.php

10. Conclusion

It would mean little to predict how the *Energiewende* will turn out in 2050. But, extrapolating from the recent past, some meaningful guesses can be made about 2020:

- Germany will probably succeed in hitting its renewable target for 2020. To achieve this, it only has to maintain over the next eight years the same momentum in deploying renewables that it has shown in the past 10 years. The feed-in tariff, especially if unreformed, is a powerful driver of investment. Doubt about reaching the 2020 target would arise if renewable subsidies were very sharply reduced.
- Germany will probably miss its emission reduction target for 2020. Its greenhouse gas emissions are slightly higher than the EU average, due not so much to excessive energy use as to a relatively carbon-rich energy mix. Despite the one-off emissions improvement from the closure in the 1990s of inefficient and polluting plant in the eastern länder, it still uses dirty lignite there to generate power. Most of the new conventional capacity coming on stream is coal. Using coal/lignite as the short-term replacement for nuclear power and back-up for renewables must jeopardise the emission target.
- Germany will probably fail to meet its 2020 target of an absolute 20 percent reduction in energy consumption. To achieve this, the country would have to raise energy productivity above its historic rate. Even less likely to be achieved is the 10 percent reduction in electricity consumption by 2020, unless the government goal of putting 1 million electric cars on the road by 2020 is abandoned. If it is abandoned, then Germany is unlikely to meet its carbon emission reduction target, especially as it begins to close more nuclear reactors after 2015.

One should not be too pedantic, however, about targets. Even partial transformation of such a big industrial economy to a lower carbon system would be remarkable. The country has taken a big gamble, and is paying a price. The direct financial cost of the early retirement of the nuclear reactors is being borne by the big utilities and one of their executives called this loss (€100 billion in net present value terms) ‘the biggest destruction of value since the second world war’. Yet the whole country is paying the high annual cost of replacing nuclear power and accelerating energy efficiency. In addition to public investment, consumers paid €13.2 billion (0.5 percent of GDP) in feed-in tariffs in 2010.²² In their official forward estimate of EEG-Umlage costs, the TSOs predict that the cost will be €15bn in 2012. Moreover, there is a risk of losing energy-intensive industries.

But the gamble is partially paying off. Talk of de-industrialisation is, so far, only that. The country has gained jobs and exports in renewable energy. Its high rate of innovation in environmental technologies – it was third behind Japan and the US in the number of environmental patents awarded in 2007 – holds the promise of more jobs and exports to come.²³

²² OECD, *Economic Survey of Germany*, 2012, page 99.

²³ Ibid, page 108.

Policy is still evolving in what seems to be the right direction. Responsibility for energy is divided between the economics ministry (in charge of conventional energy supply, energy efficiency and energy market arrangements) and the environment ministry (responsible for renewable energy and, through health and safety issues, for the nuclear sector). There is an innate tension between the two ministries, especially because in Germany's habitual coalition governments the ministers are usually from different parties. This makes for policy-making that is openly messy. But the tension can produce a useful synthesis. The environment ministry's greens have clearly predominated in setting the goals of the *Energiewende*, but pressure from the economics ministry's pro-marketeers seems to be helping to scale down the cost of implementing those goals. Philipp Rösler, the economics minister, has been right to warn of the 'sweet poison' of renewable subsidies, though free market liberals like him may also have to accept that, in the area of energy saving, more regulation may be needed, not less.

The notion of competition in energy, never widely or warmly embraced in Germany, has fallen out of fashion recently. It is increasingly hard to sustain in the electricity market. Renewable targets and subsidies mean that an ever-larger slice of the electricity market operates on non-market lines. The economics ministry is understandably cautious about a further shrinking of the 'competitive' part of the power market arising from the introduction of a capacity mechanism. Competition, however, is still very possible and relevant to the German gas market, particularly to encourage gas-on-gas competition and to reduce the amount of gas sold at high oil-linked prices. Such a development is vital to ensure lower prices for gas as a relatively clean back-up for renewables.

In taking its unilateral nuclear phase-out decision, Germany was rather cavalier about the consequences for its EU neighbours and partners. However, it may need their help if it is to contain the costs of its *Energiewende*. Berlin now has a strong self-interest in the building of more cross-border electricity and gas interconnectors, and in the European Commission's proposals to speed up the permitting and help the financing of priority pan-European energy infrastructure. The more Germany feels it can reliably draw on its neighbours' energy capacity to meet any interruptions in its own wind or solar power, the less back-up capacity it will have to build at home. Germany, too, wants the cooperation of its EU partners to raise the energy efficiency standards of products put on the European market.

There are two other ways in which, objectively the EU could help, though Berlin would not see this as such. One is a tightening up of the Emissions Trading System by removing some carbon permits, so raising their price and giving scope for a corresponding reduction in national renewable subsidies. Of course, the ideal for both Germany and the whole of Europe would be an international climate agreement. Anything that binds countries outside Europe into efforts to curb carbon emissions would ease Germans' concerns about the *Energiewende's* impact on their competitiveness. Such an agreement, however, may not be possible for some years. In the absence of an international accord, Germany will not want to tighten up Europe's own carbon permit system. Berlin, like other EU governments, has been given the green light by the European Commission to subsidise the cost to its energy-intensive companies of ETS carbon allowances. The higher the price of these allowances, the bigger the subsidy Berlin might have to pay out. Anything allowing a reduction in

renewable subsidies, however, would be a prize worth having. Such a reduction might not mean slower development of renewables, given the grass roots enthusiasm of energy cooperatives for the *Energiewende*. But if it did result in slower development, so be it. Slower might be sounder.

The other form of help, objectively, would be a Europeanisation of national renewable support schemes. The renewable industry would fight this, because they would, correctly, see it as involving a dilution of the German national subsidy system. But German subsidies for new renewable projects are in any case being cut back, heavily in the case of solar power, because of growing resistance of energy consumers to paying the rising cost of the subsidies. Manufacturers of wind turbines and solar panels might not mind a lowering of German subsidy levels in a Europeanised scheme if it also had the effect of raising the level of support in other European countries, where there would be more money to buy German turbines and panels.

At present, however, Europeanisation of national renewable schemes would be seen in Germany as another step taking the EU towards a 'transfer union'. But that is part of a bigger argument rocking Europe, and quite another story.