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The True Challenges Facing the German Energiewende

Two years after Fukushima the road to a renewable future is gradually becoming clear

by Rainer Baake, Director of Agora Energiewende

A new German expression is making its way into the English language, joining *Kindergarten* and *Zeitgeist* – *Energiewende*. Directly translatable as "energy transformation," it refers to the broad effort underway in Germany to remake the country's energy economy and transition to renewables. This effort has attracted international attention. And the adoption of the term in English reveals a certain sense of wonder. For indeed, if the phasing out of coal, gas, and nuclear in favour of wind and solar were an everyday affair, there would be little reason to memorize a cumbersome new German term.


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For the outsider, Germany's decision to abandon fossil fuels and nuclear power may seem unusual, if not downright crazy. After all, prevailing wisdom in many quarters is that only conventional fuels are sufficiently cheap and effective in the long term to quench demand. Yet fossil fuels are a limited resource, and they damage the climate. Furthermore, the Fukushima disaster graphically demonstrated the risks of nuclear power. Thus, a reliance on electricity from coal and uranium is clearly not sustainable. And it is precisely this insight that is propelling Germany's resolve to transform its energy economy. The aim of phasing out nuclear power and developing renewables was first ratified by the German government in 2000. It was a highly contentious decision at the time. Since Fukushima, however, a broad consensus has emerged in the German Bundestag. All of the major parties – whether in the current administration or part of the opposition – have committed themselves to the Energiewende.

Two years have now passed since Fukishima, and the resolute mood in Germany witnessed in the weeks and months after the disaster have given way to a measure of disenchantment. In particular, the costs of the Energiewende have been the subject of heated debate. Of course, these costs are an important issue, yet it was apparent from the beginning that the efforts required would be multifarious and large, and that the transition to renewables would not come cheap.

Wind and solar

The effort to construct an electricity supply system based on renewables in a relatively densely populated country with a central European climate is no easy one, as there are clear restrictions on the sources of energy that can be developed. The potential for geothermic energy is rather small in Germany, as – perhaps fortunately – the country is quite boring from a seismic perspective. Hydroelectric power could be a candidate, yet there is a lack of locations available for the construction of hydroelectric power plants. The outlook for biomass is not much better. Biomass has already encountered major acceptance problems in Germany. Thus, only wind and solar are sufficiently abundant to meet Germany's power needs. Accordingly, we can say with assurance that in Germany, the shift to renewable energies will succeed based on wind and solar, or it will not happen at all.

Both of these sources of energy have characteristics that are forcing Germany to reinvent its power infrastructure. First, energy generation is weather dependent, and it cannot be easily modulated to respond to changes in demand or wholesale prices. A second and associated characteristic of this weather dependence is that production yields can fluctuate rapidly. Third, wind and solar plants are capital intensive, yet have extremely low operating costs. As a result, after the initial investment in a plant, electrical power is virtually free over the next two to three decades.

Less than ten years from now, power production from renewables will exceed demand at various times during a

given week – particularly during periods of peak demand in the middle of the day (because of photovoltaics). Yet there will be other times, especially during the winter, when renewables generate very small quantities of electricity. Thus, the Energiewende is first and foremost a problem of synchronization. How can we bring fluctuating production from wind and solar together with demand from consumers?

Part of our mission at Agora is to develop insights that allow such questions to be answered. Yet equally as important is our quest to educate policymakers and business leaders about their role in the Energiewende. To this end, Agora tries to stay out of day-to-day political debates. Instead, our aim is to pave the way for the adoption of solutions. In this regard, we are not just focused on good solutions from a technical perspective, but also on solutions that are economically affordable. In our view, the following rule of thumb should apply in the efforts of policymakers to encourage the transition to renewables: foster as much competition as possible, and regulate only to the extent necessary. Indeed, it is the responsibility of policymakers to productively harness the competitive forces of the marketplace, thus enabling the best solutions to emerge.

The shift to renewable energies will succeed based on wind and solar, or it will not happen at all

In our "12 Insights on Germany's Energiewende" we outlined a working program for achieving the transition to renewables over the next several years. This nearly 40-page publication, which was presented at the end of 2012, met with broad approval from political parties, associations, and the energy industry. We consider these 12 insights to be a solid foundation for achieving consensus regarding the proper trajectory of the Energiewende.

Starting from the basic recognition that a focus must be placed on developing wind and solar, the 12 Insights lay out in detail the changes needed to Germany's energy system. With a system largely based on wind and solar, there is no longer room for "baseload power plants" that run on fossil fuels. However, power plants will still be needed to compensate for fluctuating generation from wind and solar, in order to ensure that power supply can meet demand.

Power production on demand

To compensate for fluctuating generation from renewables, it will help to make the production and consumption relationship more flexible. For example, heat and power cogeneration plants and biogas facilities could be managed to produce power according to demand instead of the way they are set up now – i.e. continuously producing the same amount of power. Similarly, industrial and commercial customers could power on and power off their heaviest power-consuming machinery – such as refrigerators and compressor units – according to conditions in electrical grid. Implementing such flexible arrangements would require both legislative action and the creation of financial incentives.

The expansion of the electrical grid will be a key factor for the success of the Energiewende. The larger the area that is connected through high-voltage networks, the easier it is counterbalance fluctuating supply and demand – whether within Germany or across Europe. Large networks also make it possible to access more cost-effective options over great distances. Thus, when large amounts of power are being produced from wind and solar, electricity can be sold to neighboring countries. As early as 2020, it is anticipated that Germany will periodically experience 22-gigawatt power surpluses – a quarter of annual peak load. In an electricity system with a high ratio of wind and photovoltaic electricity, temporary surpluses are a normal occurrence. Yet a popular alternative to grid expansion – the construction of facilities to store surpluses of electrical power – would be many times more expensive. In fact, we will only need new storage technologies such as power-to-gas once renewables make up more than 70% of power generation. Until then, it makes more sense to fully utilize less expensive options.

In 2021 and 2022, the last and largest nuclear power plants in Germany are scheduled to shut down

Another economical solution would be to promote integration between the heating sector and the electrical grid. This is not a plea for the expanded use of night storage heaters. Instead, we advocate operating heat-and-power cogeneration plants according to electricity demand, and not according to the demand for heat. Heat can be stored easily and inexpensively – for example, using insulated water tanks. These plants could be used to absorb surplus energy from the power grid, and, in this way, conserve fuel at other locations.

In 2021 and 2022, the last and largest nuclear power plants in Germany are scheduled to shut down. Already today, the low wholesale prices for electricity on energy exchanges are discouraging investment in flexible backup capacities to supplement renewable energy. Worse yet, it is no longer economically profitable to operate many existing power plants. As a result, we can count on significant numbers of such plants being decommissioned.

We regard this prospect as highly dangerous. If we rely on the market to assure security of supply and fail to intervene, this could lead a situation in which sufficient controllable production capacities are not available at all times – that is, fossil-fuel power plants and storage facilities on the supply side, and, on the demand side, shiftable loads. A consequence will be the threat of blackouts during peak load periods. Ultimately, this could even jeopardize the phase-out of nuclear power.

One possible response would be to pass a regulation that forbids the decommissioning of a systemically relevant power plant. Naturally, operators would have to be compensated for such an encroachment on their property rights. An alternative would be a capacity market, developed by harnessing the creativity of the free-market. A government agency could define the necessary controllable capacity for preventing blackouts and solicit bids for the most cost-effective solutions. Yet the demand side would also have to be integrated. Indeed, if it is more cost efficient to shift the timing of demand than to maintain a power plant to cover a few hours of peak load, why not select such an approach?

The primary tool used in Germany to promote the development of renewables – the German Renewable Energies Act – will also need further refinement. Changes are needed in order to take into account the specific characteristics of wind turbines and photovoltaic power plants. Current law will make it impossible for these power plants to recoup their costs on the electricity power market of the future – even if their total costs per kilowatt-hour fall below those of coal and gas power plants. Why? Because wind power and photovoltaic plants have virtually zero short-term operating expenses or marginal costs. Thus, in a spot market based on marginal costs, these plants bring about a price collapse. This effect becomes more pronounced as more wind turbines and photovoltaic plants are constructed. When a lot of wind and sun is available, they are unable to earn any money, since the wholesale price drops nearly to zero. And when there is no wind blowing and the sun is not shining, they cannot sell any power.

Even if the task ahead is large, it is not without precedent

This is not to argue that government-mandated feed-in tariffs should continue forever. It is an argument, however, against the mistaken belief that a decrease in the costs to construct wind turbines and photovoltaic plants is the only thing required to straighten out the market. In the same way that we must build an additional income stream for conventional power plants as a way of setting aside controllable capacities to assure continued security of supply, we also need to provide an additional revenue stream for renewable energy besides revenues from the electricity market. Otherwise the Energiewende will come to a standstill.

We would be a bad partner to the rest of Europe as well as stupid if we regarded the Energiewende as an opportunity to transfer responsibility for energy policy away from the EU and back to Germany. All of the measures cited above would be easier to implement and more cost-effective if they were conducted in close coordination with Germany's neighbors. A few of them are already pursuing goals similar to Germany's. Cooperation is foreseeable in numerous areas – for example, to build energy storage facilities in Scandinavia or set up capacity markets. Yet in order for cooperation to occur, guidelines are necessary, and this necessitates political will on both sides of the border. One thing is clear: International cooperation will be needed to make sure the Energiewende is a success.

Electrical supply system top of the world

Even if the task ahead is large, it is not without precedent. If we take a look back at the history of Germany's power supply system, it is clear that changes have taken place in every era. It has always been a matter of adapting the system to changing conditions and needs.

- The first transregional high-voltage network in Germany was built in order to connect the power plants near the Rhenish-Westphalian coal fields to the hydroelectric plants in the Alps – a project that truly involved entering uncharted new territory.
- Between 1977 and 1989, when a new nuclear power plant went online virtually every year, the electrical grid was expanded to an extent scarcely imaginable today: more than ten thousand kilometers of new high-voltage power lines were constructed in Germany during this period. By comparison, the infrastructure changes required by the Energiewende seem rather small.
- The last major change in the system was the liberalization of the electricity market. A regulatory design for the market was conceived, market rules were established, and an electricity exchange came into being. There is nothing to stop us from changing the market again in the face of changing needs.

In the past, these challenges were successfully surmounted – indeed, Germany's electrical supply system is among the most secure and reliable in the world. With a measure of resolve, the Energiewende can succeed as well.

Contributions

Sorry I don't understand how the authorization and building, in the next 10 years, of 22000 MW of coal power plants (with the biggest coal power plant of the world in Renania North Westphalia'Neurath- just coming online) fits in with the renewable energy strategy . Thanks . Best regards

Lorenzo Pinna

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