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Dossier

26 Jan 2015 | [Kerstine Appunn](#)

The energy transition and Germany's power grid

Connecting up the Energiewende

Tags: [Grid](#)

As the German power system shifts to renewable sources the network must be updated to cope with decentralised, fluctuating supply. But not everyone is in favour of grid extensions needed to bring electricity from the rapidly growing wind power capacity in northern Germany to the country's industrial south. (Corrects unit to megawatt-hour (MWh) from previous kilowatt-hour (KWh) in sixth paragraph below sub-headline "consumers pay")

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Their names were Elon and Felix and at a certain point on Friday 9 January they powered the generation of 30,700 megawatts (MW) of electricity between them. On the weekend when these two low-pressure weather systems blew over Germany, the country's wind turbines produced electricity equivalent to 25 nuclear power stations.

But this new record for renewable power generation wasn't only a cause for celebration. Grid operators soon calculated that keeping the network stable under this sudden influx of wind power cost around 13 million euros, highlighting once again the missing link between the power system in windy north-eastern Germany and high demand in the country's industrial south.

Germany's Energiewende – the transition to a low-carbon economy whose energy needs are largely satisfied by renewable sources – needs adaptations to the power system, including the transmission grid and power distribution network. The growth of renewable capacity (the [share of renewables in German power generation](#) rose from 3.6 percent in 1990 to 25.8 percent in 2014) means that more and more power is fed into the grid from a multitude of small, decentralised sources, and – depending on the weather – in unpredictable quantities.

So far, Germany's power grid ranks among the most reliable in the world despite the rapid increase in renewable energy. Its System Average Interruption Duration Index (SAIDI), which measures the average yearly downtime per customer, was 15.91 minutes in 2012, meaning it suffered a quarter of the disruption of the UK grid (See Figure 1 below), and dropped further in 2013 to 15.32 minutes (See [CLEW Factsheet on the set-up of Germany's power grid](#)).

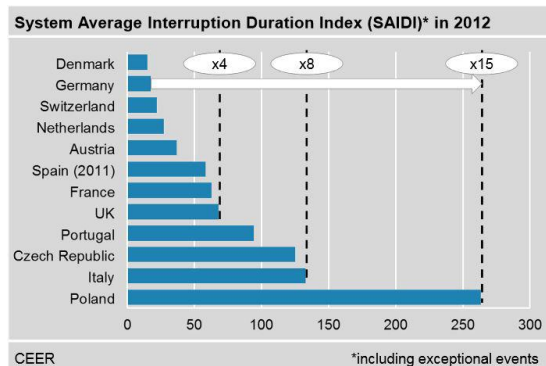


Figure 1| International comparison of grid stability. Source Agora Energiewende/Council of European Energy Regulators (CEER)

In order to accommodate large influxes of renewable power and keep the grid stable, the [Federal Network Agency](#) (Bundesnetzagentur) and the four transmission grid operators ([TenneT](#), [50Hertz](#), [Amprion](#), [TransnetBW](#)) have put forward plans to expand the power network. But while the growth of renewable installations – from solar panels on detached houses to wind turbines in fields and along the coast – have triggered relatively little opposition from citizens, overland grid connections are far more controversial.

Backing citizens' associations attempting to prevent power lines running "through their backyard", the [Bavarian state premier](#) defied federal government plans to rapidly develop grid connections between the north-east of Germany and the south. With grid planning and construction already taking an average of ten years, these further delays are one of the major challenges that Germany now faces in the implementation of the Energiewende.

Another recent record from the German renewables sector could compound the problem. The [offshore wind](#) energy sector announced that by the end of December 2014, [offshore wind](#) capacity feeding the German grid passed the 1,000-megawatt mark. The construction of a further 1,200 MW was completed last year, [Deutsche WindGuard](#) said, but these turbines are yet to be connected to the network. Together with installations to be constructed this year, a total of up to 2,000 MW of new offshore capacity is expected to go online in 2015.

"It's foreseeable that Germany will have the third largest [offshore wind](#) capacity in Europe, following the UK and Denmark," said Norbert Giese, chairman of the German Engineering Association ([VDMA](#)) steering committee for the [offshore wind](#) industry.

But north Germany's growing wind power capacity puts increasing pressure on the grid. "As long as the new power lines between north and south Germany are not completed, the problem of a lopsided system that requires frequent interference from grid operators will only worsen," Andreas Jahn of the [Regulatory Assistance Project \(RAP\)](#) told the Clean Energy Wire.

Even Germany's neighbours have felt the surplus of renewable power that windy days have landed on the grid: in [Poland](#), an overspill of electricity from Germany and Denmark forced grid operators to shut down plants and disturbed their load planning. At times, power exchange between Germany and Austria took place via the [Polish network](#). Because of this, so called [phase shifters](#) will be installed at the German-Polish border in 2015, enabling grid operators to control the flow of power crossing the border. [Similar problems](#) occur between Spain (wanting to export renewable power) and France (saying that this would interfere with running its nuclear power stations).

But cutting grid connections between countries is in contrast to German and European Union plans for an [Energy Union](#) that would interconnect and diversify EU members' energy sources, reducing dependency on non-EU suppliers. The German government said in an internal paper seen by the Clean Energy Wire that it supports “cross-border grid reinforcement” and a 10 percent goal for [inter-connection of installed electricity production capacity](#) in all member states by 2020. [In an interview](#), economy and energy minister Sigmar Gabriel said security of supply could be best achieved through increased cross-border connections, eventually reaching a level of integration where not every country would need to hold power for its per-day maximum load on its own grid.

Bilaterally, Germany is planning grid connections with Norway via a [1,400 megawatt sub-marine cable](#), which will transport German renewable power to and from Norwegian [hydropower storage](#) facilities. Grid operator [Amprion](#) in North Rhine-Westphalia and Belgian counterpart Elia are planning the [first power line to connect Germany and Belgium](#). The 1,000-MW capacity line is due to be completed in 2019.

The German grid regulator, [Bundesnetzagentur](#), has repeatedly indicated that an added 2,650 km of domestic power lines are [needed by 2023](#). In particular, two high-voltage direct-current transmission lines, the SuedLink between Wilster (near Hamburg) and Grafenrheinfeld in Bavaria (See map), and the “[Gleichstrompassage Süd-Ost](#)” line from Saxony-Anhalt to Bavaria, are seen as essential to transport wind power from north to south. But their construction is yet to begin.

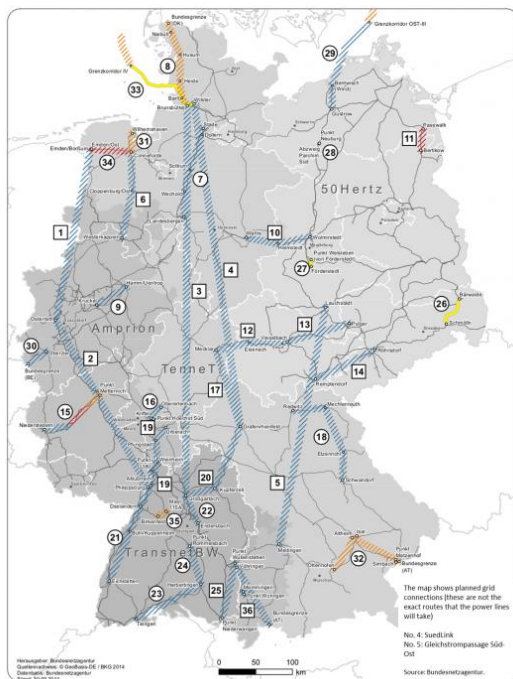


Figure1 Grid expansion planned according to the "Bundesbedarfsplan"; other projects like the “South-west interconnector, including the “Thüringer Strombrücke” from eastern Germany to Bavaria are based on 2009 EnLAG legislation and are partially finished (See Factsheet Grid organisation).

More grid vs. a decentralised power system

First, Bavarian citizens' groups complained about potential power lines running past their towns and villages. Then Bavarian state premier [Horst Seehofer](#) took up the issue and wondered if Bavaria could not cope by building up its [gas-fired power capacity](#), or importing more power from Austrian [hydropower](#) plants. Later, Seehofer announced that a process of consultation was needed to decide whether the power lines were really necessary. The results of this “Energy Dialogue” are expected in February 2015.

While Seehofer received support from his counterpart in Thuringia, through which the “Gleichstrompassage Süd-Ost” line to Bavaria is supposed to pass, the Chambers for Commerce and Industry (DIHK) and the power sector represented by the German Association of Energy and Water Industries (BDEW) made it clear that his arguments were not supported by businesses. “Federalism is a high good but no excuse for a lack of responsibility in politics. I cannot agree one day to the federal plan for grid extension and the next day I am against it. This is not the environment we need,” BDEW president Johannes Kempmann said in January.

Expanding the gas-fired power supply in Bavaria would increase its dependency on natural gas imports from Russia and would be expensive, an [analysis by the DIHK](#) found. Seehofer's argument that power lines from eastern Germany would bring electricity mostly produced from coal and [lignite](#) to the south was “physically and economically not comprehensible,” the paper says.

Yet some scientists and many citizens have argued that the additional power lines suggested by the grid operators are not all needed. Professor [Lorenz Jarass](#) from the RheinMain University of Applied Sciences has calculated that less additional grid would be needed if official plans took into consideration that generation from conventional power stations and renewable sources should be curbed in the event of a storm. [Citizens in power line-affected regions](#) tend to argue that the energy transition should lead to a decentralised power system where every region becomes self-sufficient, reducing the need to transfer electricity over large distances. A [study](#) by the Federal Environment Agency (UBA) has shown that such closed systems would work in rural areas, but only with immense additional power [storage](#). And the cost of becoming self-sufficient would be even higher in southern Germany than in the north. Rural areas with business and industry as well as urban settlements could not become self-sufficient at all, the study found.

With both onshore and [offshore wind](#) power capacity in northern Germany still expanding, grid operators like [50Hertz](#) and experts including the RAP's Jahn are adamant that grid expansion is needed – and fast. “Otherwise, we will have the situation of the last stormy weekend more often,” Volker Kamm, spokesperson for [50Hertz](#), told the Clean Energy Wire.

Chancellor Angela Merkel has also made her position clear: “If the southern states are saying they can import power from Austria instead – that ‘we are not interested in the wind in northern Germany’ – then we have a huge problem,” Merkel said at a reception of the [German Renewable Energy Federation \(BEE\)](#) in January.

Consumers pay

Grid operators like [50Hertz](#) and Tennet have a particular interest connecting up the grid. And so do consumers: whenever the grid operators have to interfere with the input and output of the power network it costs money. [50Hertz](#) did a rough calculation of 7 million euros of added “re-dispatch” costs as a result of storms over the weekend of 9 till the 11 of January 2015, with Tennet estimating 6 million euros over the same period.

Normally, supply and demand on the power market determine which power stations deliver a given amount of electricity on a given day (See CLEW factsheet [merit order effect](#)). Grid operators receive a power plant “dispatch” list, based on the market figures a day ahead, allowing them to check whether adjustments are needed to ensure the network runs smoothly.

On the weekend of Elon and Felix, they indeed had to adjust, taking several re-dispatch measures. At peak times, [50Hertz](#) had to throttle more than 6,700 MW of conventional capacity to allow for excess wind power, Kamm explained. When this was not enough, the grid operator had to temporarily shut off some 800 MW – or 300 wind turbines – in eastern Germany to stabilise the system. At the same time, Tennet and [50Hertz](#) had to tell power stations in the south of Germany to ramp up production because not enough of the excess power in the north could be funnelled through existing power lines to Bavaria and Baden-Württemberg.

This ramping up and suppression of generation resulted in the extra costs. The coal-, gas- and oil-fired power stations in southern Germany that grid operators use for re-dispatch generate power at costs higher than the market price. And when power stations are told to limit production, they must receive compensation (minus expenses the power plants save on fuel). Grid operators pass on these costs to consumers in the form of a grid fee that households pay via their electricity bills.

“Essentially, this means that consumers in north and eastern Germany where most of the wind power capacity is located, and where [50Hertz](#) operates, pay for the fact that southern Germany does not agree to have power lines built to receive the electricity,” said Jahn.

Meanwhile, large industrial consumers save money thanks to the strong wind, because the increased input of cheap renewable power forces down the prices on the power market. Between mid-December 2014 and mid-January 2015 the average wholesale power price fell to 23 euros per megawatt-hour (MWh), nine euros less than the 2014 average, Jahn said.

When renewable power producers are disconnected from the network, grid operators must also compensate them for some of their lost profit, but these costs are smaller than those for re-dispatch measures, Kamm said. In 2013, 7,695 hours of re-dispatch interventions concerning 4,390 gigawatt-hours (GWh) were necessary, costing 132.6 million euros, the [Bundesnetzagentur reports](#). This was less than in 2012, and compared to the [23 billion euros](#) consumers paid for renewable electricity in 2014 via the renewables surcharge, it is only a small proportion of the costs linked to the growth of renewables.

Still, with an added 2 gigawatts (GW) [offshore wind](#) capacity, critical situations for the grid and re-dispatch measures will potentially multiply, Kamm said. “Finishing the South-West Interconnector between Thuringia and Bavaria (Thüringer Strombrücke) which is now partially built, would mean a lot of stress relief in the coming years and the 250 to 300 million euros in construction costs would be recovered within a few years.” On 21 January [TenneT announced](#) it had received permission from the regional government in Franconia (Bavaria), to build the part of the South-West interconnector running from Altenfeld to Redwitz and said it expected [50Hertz](#) to receive permission for its connecting power line in the Thüringer Wald soon.

SuedLink or different price zones

“The grid expansion and building SuedLink would definitely be the most cost-efficient method of solving the re-dispatch problem,” power market researcher Simeon Hagspiel from the Institute of Energy Economics at the University of Cologne ([EWI](#)) told the Clean Energy Wire.

Other possibilities would be to curb the feed-in priority for renewables, or to split Germany into two [different power price zones](#). “From an overall economic perspective it would make sense to divide the German power market into a northern zone and a southern sector including Bavaria and Baden-Württemberg,” Hagspiel said. A [study](#) for the European Commission concluded that power prices could rise to ten percent more than those in the north.

While the Federal Ministry for Economic Affairs and Energy participates in Bavaria's “Energy Dialogue”, the patience of the Minister and his advisors is wearing thin. “I said it in Munich and I say it again in Berlin: There are no white-and-blue [editor's note: Bavaria's national colours] electrons and there is no white-and-blue energy transition. Either we manage the grid expansion or we will get two separate price zones, for economic, technical and legal reasons,” Urban Rid, head of energy policy, power and grid at the ministry said at a conference in Berlin.

Kamm at [50Hertz](#) is sceptical of this solution, too: “It would be problematic for businesses and consumers in southern Germany if they had to pay a higher power price. And instead of getting renewable wind power from northern Germany they would probably start importing coal, oil or nuclear power from the Czech Republic,

Slovenia or Austria.” Since Bavaria will see [5.3 GW](#) of nuclear capacity shut down by 2022, the state also needs capacity to compensate for this loss.

The offshore sector would be happy to deliver – provided power lines are built for it. But in the meantime it refuses to be distracted from its growth targets because of grid expansion issues. “Of course the complexity of running the grid will increase but it would be exaggerated to fear any kind of collapse, Hermann Albers, president of the [German Wind Energy Association \(BWE\)](#) told the Clean Energy Wire. “But we are sure that the bottleneck between north-east and south Germany will be fixed.”

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