

Electric Power & Natural Gas Practice

Germany's energy transition at a crossroads

Germany has been a leader in the transition toward a low-carbon-energy system, but it will still miss most of its energy-transition targets for 2020. Urgent action is needed to get back on track.

by Fridolin Pflugmann, Ingmar Ritzenhofen, Fabian Stockhausen, and Thomas Vahlenkamp



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For a long time, Germany was a pioneer in climate protection and perceived as a global role model for a successful energy transition. As early as in 2000, Germany implemented the Renewable Energy Sources Act, which supported the large-scale build-up of renewables under an expensive feed-in tariff scheme. As a result, installed solar-photovoltaic (PV) and wind capacities have soared from 6.2 gigawatts to 83.8 gigawatts between 2000 and 2015. During this time, Germany accounted for 33 percent of the renewable buildup within the European Union. In addition, the policy has led to the creation of a considerable “green” industry: German companies used to be global champions in the production of solar-PV cells as well as wind turbines, developing cutting-edge technologies and creating jobs for several-hundred-thousand employees.

Based on this impressive trajectory, Germany set itself ambitious targets to further accelerate the energy transition. According to the plans of the federal government, significant progress in the transition to less carbon-intensive and yet still secure and affordable energy supply should be achieved by 2020. With this milestone year approaching, it is time for a comprehensive progress review. Today’s necessary message is clear: the country misses key targets. (For more on the research underlying this article, see sidebar, “The German Energy Transition Index.”) Recent course-correction efforts by the federal government have not yet been far-reaching enough to bring lasting improvements. Meanwhile, problems are emerging in all three dimensions of the “energy triangle.” These recent struggles in Germany illustrate the potential pitfalls of a fast energy transition, but they can provide important lessons for other countries endeavoring on their energy transition.

Falling behind on environmental sustainability

On the core issue of environmental sustainability, the energy transition is lagging far behind its 2020 targets. In 2018, 866 million tons of CO₂ equivalents (CO₂e) in emissions were released. While this amount represents a 4.5 percent drop from the previous year, it was still 116 million tons above the target of 750 million tons for 2020. The improvement seen last year, which was temporary

and largely due to weather conditions, does not change the long-term trend. If the pace of emission reduction from the past decade continues, Germany will hit its 2020 targets eight years late, and will only meet those for 2030 in 2046.

The Energy Transition Index reflects this sluggish progress. At no point since the index’s inception has the intermediate CO₂e emission target been met 100 percent, and currently this indicator stands at 61 percent. Indicators of primary energy consumption and electricity consumption also show low levels of target achievement—57 percent and 39 percent, respectively. The likelihood of reaching these targets by 2020 is therefore classified as “seriously off track.” Furthermore, the extent to which electricity-consumption targets are met has been falling since 2014 (Exhibit 1).

The main reason is that to date nearly all CO₂e savings stem from efforts in the electricity sector, where emission reductions are primarily due to the expansion of renewable-energy sources, along with the decommissioning of older conventional power plants and the surcharge for CO₂ within the

The German Energy Transition Index

McKinsey has tracked the development of the German energy transition since 2012, with an “Energy Transition Index.” The index is composed of 15 indicators along the three dimensions of energy supply: environmental sustainability, security of supply, and economic development and growth—the so-called “energy triangle.” Indicators record the extent to which each politically defined energy-transition target is achieved, and thus if Germany’s energy transition in each area is well on track, if it requires minor adjustment, or if the target achievement is seriously off track.

On environmental sustainability, progress lags behind 2020 targets.

Extent to which targets are achieved, % of target



¹ Sample calculation, achievement of renewable-share target: 0% \pm 17.0% renewable share; 100% \pm 31.4% renewable share (in 2018); current value is 37.8% $(37.8\% - 17.0\%) / (31.4\% - 17.0\%) = 144\%$.

² CO₂ equivalent.

Source: Federal Ministry for Economic Affairs and Energy (BMWi); German Environment Agency (UBA); Working Group on Energy Balances (AGEB)

European emission-trading system. In the first half of 2019, electricity-sector emissions were about 15 percent lower than they were during the same period in 2018. According to the German Association of Energy and Water Industries, this drop was caused by record generation from

renewable sources, a higher price for CO₂, and mild weather conditions. The amount of electricity generated from renewable sources has surpassed the 2020 target (35 percent of total gross electricity consumption) since 2016. Currently target achievement for this indicator is 144 percent.

However, the electricity sector's progress has not yet been replicated in the transportation, building, or industry sectors. In the transportation sector, emissions increased from 153 million tons to 162 million tons of CO₂e (an increase of 6 percent) since 2012. The rise in passenger vehicle traffic (increase by 5 percent) more than offset the reduction in emissions per kilometer driven (decrease by 3 percent), resulting in a negative balance overall. In the industry sector, CO₂e emissions increased from 180 million tons to 196 million tons (increase by 9 percent). Finally, emissions fell in the building sector, but only from 130 million tons to 117 million tons of CO₂e—a drop of just 10 percent.

Substantially lowering CO₂e emissions will not only require further action to increase energy efficiency but also a higher level of sector coupling—in other words, comprehensive electrification of the transportation, building, and industrial sectors. In this way, these sectors can fully benefit from energy sources, such as wind- and solar-power systems, that do not generate CO₂e. Despite the importance of sector coupling, the Energy Transition Index does not yet provide a quantitative value for the sector-coupling indicator, because no overarching targets had been clearly formulated for this area.

Security of supply under pressure

Germany has enjoyed a highly secure electricity supply for decades, but the tide is beginning to turn. The German power grid repeatedly faced critical situations in June of this year: significant shortfalls in available power were detected on three separate days. At its peak, the gap between supply and demand reached six gigawatts—equivalent to the output of six major power plants. Imports arranged on short notice from surrounding countries were required to stabilize the grid. Also, the price for balancing energy jumped to €37,856 per megawatt-hour in one instance. In 2017, the price for balancing energy averaged €63.90 per megawatt-hour. While this can be interpreted as an indicator of shortage, initial investigation has shown that changes in how balancing-energy prices are calculated and that trading behavior also played a role in this steep increase. Grid operators

have already announced that they will review the enormous price fluctuations and their causes.

The supply situation will become even more challenging in the future. The phaseout of nuclear power until the end of 2022, and the planned reduction of coal-fired generation, will gradually shut down further secured capacity. If new generation facilities are not added, the reserve margin will tumble, with consequences that vary considerably from one region to the next. Industrial areas in western and southern Germany will be hit especially hard, as large drains on capacity exist in these regions and high rates of renewable expansion are unlikely there. Furthermore, the shift from dispatchable capacity to fluctuating renewable sources could also lead to problems in situations when demand is high but supply from renewable energy is low.

The loss of generation capacity has another effect as well: Germany will almost certainly go from being a net electricity exporter to an importer, especially after 2023. In June 2019, the country imported more power than it exported for the first time in five years. However, some neighboring countries are also decommissioning power plants. The Netherlands is phasing out coal, for example, and discussions in Belgium about stopping the use of nuclear power may also result in plant closures. In the medium term, the European network as a whole could lack sufficient generation capacity.

In light of this, expanding Germany's electricity grid becomes increasingly crucial to transmitting electricity produced by the large wind capacities in the north to the demand centers in the south. Faster progress is essential to ensure the country's energy supply. By the first quarter of 2019, just 1,087 kilometers of the 3,600-kilometer transmission lines planned for that date were actually completed. If grid expansion continues at this pace, the country will not reach its 2020 target until 2037. The recently adopted Grid Expansion Acceleration Act is a step in the right direction, but the backlog will not be eliminated anytime soon. Grid expansion will become even more important from 2023 onward, when a larger transmission system will be crucial to

counteract the regional bottlenecks expected after the last nuclear plants are shut down and the first steps to phase out coal generation take place.

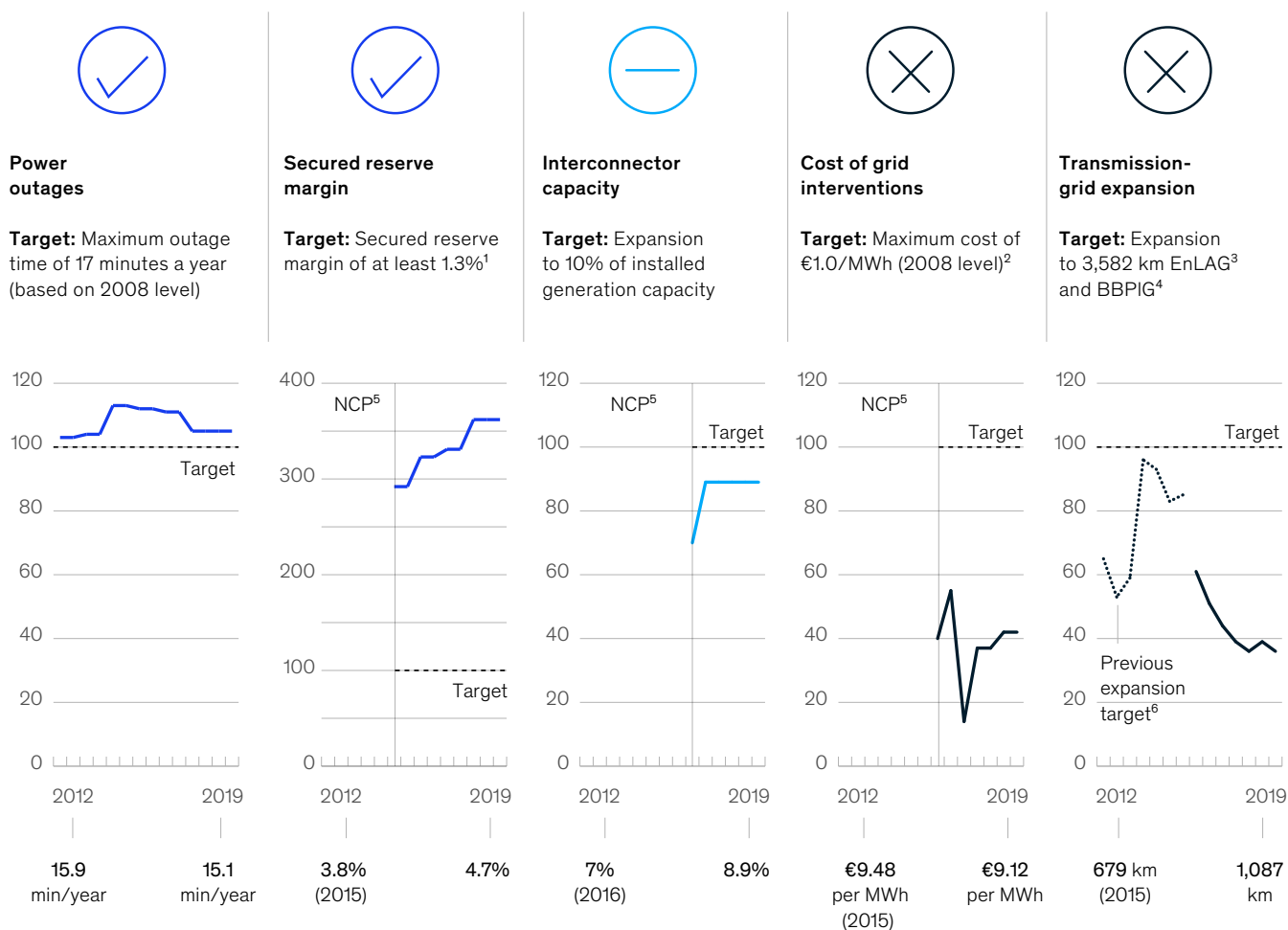
Current indicators of the security of supply reflect these problems. As just 36 percent of the transmission-grid-expansion target has been reached, the likelihood of hitting this target remains classified as “seriously off track.” No updated values are available for interconnector capacity; based on the last value calculated—89 percent—this indicator

remains in the “minor adjustment required” category. The target for the cost of grid interventions, an indicator of transmission-system stability, has been met to 42 percent, so hitting this target is considered “seriously off track” as well. What’s more, intervention for redispatching and feed-in management has increased significantly since 2016. In contrast, hitting the targets for power outages and secured reserve margin is considered “on track,” as indicators for both have been over 100 percent for several years (Exhibit 2).

Exhibit 2

Security of supply could become more challenging.

Extent to which targets are achieved, % of target



¹Based on new calculation logic used by transmission-grid operators as of 2015. ²Sample calculation, achievement of target for grid-intervention costs (redispatching, feed-in management, reserve plants): 0% \triangleq €15.07/MWh, 100% \triangleq €1/MWh, currently €9.1/MWh \triangleq (9.12–15.07)/(1.0–15.07) = 42.3%. ³Power Grid Expansion Act. ⁴Federal Requirement Plan. ⁵No comparison possible due to definition changes and data-availability issues. ⁶EnLAG; BBPIG targets added in 2016.

Source: European Commission; Federal Ministry for Economic Affairs and Energy (BMWi); Federal Network Agency; system balance report of German transmission-system operators

At the same time, the planned decommissioning of nuclear and coal-fired plants could soon dramatically change the reserve margin. In their current system-balance report, the transmission-system operators predict that the reserve margin will be negative—indicating a lack of secured power—as early as 2021. This gap will amount to 5.5 gigawatts even before accounting for the shutdown of coal-fired plants in the course of the German coal exit. A slightly positive reserve margin of 1.1 gigawatts is achieved only under the assumption that the 6.6 gigawatts of grid reserve are extended beyond 2020. From that point until 2023, at least 17.7 gigawatts of the remaining secured output will disappear as the last nuclear plants go offline and coal-fired plants follow. If peak load remains the same, the balance gap will grow to 16.6 gigawatts unless new generation capacity is added.

Electricity costs remain high

Economic development and growth have long constituted a problematic area for energy transition—especially when it comes to electricity-price development. For years, German consumers have paid more for their electricity than their European neighbors do. Today the electricity price for households is still about 45 percent above the European average. As a result, target achievement for this indicator is just 25 percent, so the likelihood of hitting this target remains classified as “seriously off track.” Conversely, the electricity price for industry continues to follow the positive trend that began in 2014, and target achievement for this indicator is 127 percent. However, the electricity price used in this analysis only applies to companies that are partially exempt from the Renewable Energy Act levy (Exhibit 3).

The high price of household electricity is mostly due to taxes and fees, which rose by 17 percent since 2012, even as costs for procurement and sales fell by 16 percent. The Renewable Energy Act levy—which increased from 3.6 eurocents per kilowatt-hour to 6.4 cents per kilowatt-hour—is a particular challenge for Germany. As a result, the level of target achievement is just 17 percent, relegating this indicator to the “seriously off track” category. Overall, levies account for 54 percent of the price of

household electricity in Germany—far higher than the European average of 37 percent. Costs for grid expansion and interventions also add to the German electricity price; fees for grid usage have reached 7.4 eurocents per kilowatt-hour, up 20 percent since 2012.

The Energy Transition Index does point to positive developments in the labor market. Thanks to the overall good employment situation in Germany, the target for jobs in energy-intensive industries has been exceeded (reaching 141 percent). The most recent figure for the indicator for jobs in renewable energies is 105 percent. In both cases, the targets have been surpassed for years. However, the current struggles of the German wind-energy industry, as one example, suggest a negative outlook.

Federal government announces climate-action concept

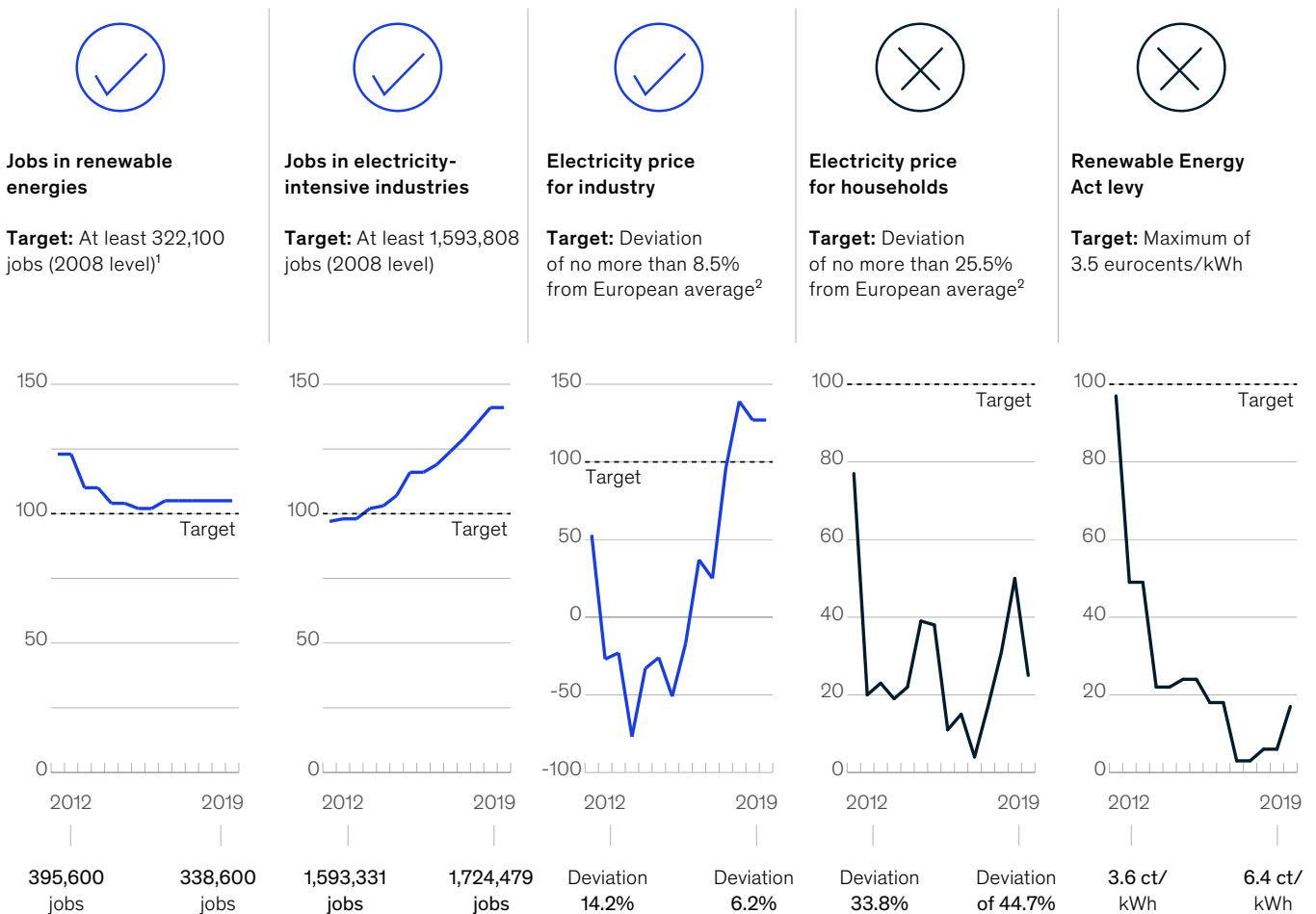
In Germany, frustration is now growing among the general population over the lack of progress in addressing climate change. The “Fridays for Future” school strikes and the good results of the Green Party in the European election are signs of broad public interest in climate protection. Pressure on the federal government is rising. It has become clear that small adjustments are not enough to get the energy transition back on track.

In September 2019, therefore, the German government agreed on a concept to reach the goal of reducing greenhouse-gas emissions by 55 percent until 2030 with annual reduction targets per sector. Several ministries had worked for months on proposals for this “climate package.” In order to ensure compliance, the reduction efforts shall be objectively monitored by an external board of experts. More than 50 measures are planned now to help accelerate the cut in emissions and keep costs under control: starting in 2021, a national CO₂ price will be implemented on emissions from the building and transport sector, complementing the existing European Emission Trading System. Furthermore, citizens will be financially compensated by lowered electricity prices, increased support payments for commuters, higher housing allowances, and tax reductions for using public transport—that’s the plan.

Exhibit 3

While household electricity prices remain high, there are positive developments in the labor market.

Extent to which targets are achieved, % of target



¹Sample calculation, achievement of renewable-energy-job target: 0% $\hat{=}$ 0 jobs; 100% $\hat{=}$ 322,100 jobs; current value is 338,600 jobs $\hat{=}$ 100%.

²Deviation in 2009–10.

Source: E-Control; Eurostat; Federal Ministry for Economic Affairs and Energy (BMWi); German Federal Employment Agency; information platform of German transmission-system operators

Although there is broad agreement that this climate-action concept is a step in the right direction, most observers consider the proposed measures as not efficient enough to reach the reconfirmed emission-reduction target of –55 percent by 2030. The biggest criticism: the CO₂ price levels are not strong enough to induce sufficient shifts in customer behavior and investments. Furthermore, the concept does not address all challenges of the decarbonization pathway until 2030 as identified

already in the Energy Transition Index. For example, while on sector coupling the concept defines specific targets in the mobility sector (7 million–10 million electric vehicles until 2030), other sector targets remain vague, for instance, with regard to buildings and heat.

Regarding energy efficiency, critics complain about a lack of a holistic perspective on the target contribution of energy-efficiency measures—and

so the government has announced the development of an energy-efficiency strategy 2050 by the end of the year. One challenge in developing this strategy is that while financial support for energy-efficiency measures shall increase, it is unclear to what extent the measures will contribute to reducing energy consumption. At least electricity consumption can be expected to increase further, despite efficiency initiatives, due to further advances in electrification.

Objectively, too, it can be stated that these measures do not sufficiently address the security of supply concerns in Germany, as it relies on overcapacities in the European electricity system. However, as dispatchable capacity decreases across European countries, it is certain that further action is needed to secure Germany's energy supply in the medium to long term and to prevent the high macroeconomic costs of potential bottlenecks. In particular, four additional types of action at the federal-government level should be considered: first, grid extensions need to be accelerated to enable the integration of more renewable power. Second, capacity for peak loads should be expanded to compensate for the secured capacity that will be eliminated, or existing backup capacity should be maintained until compensation is online. Third, to secure supply in the short term, Germany could enter into contractual agreements with foreign power plants to provide power when domestic supply bottlenecks occur. However, as other countries also plan to shut down secured

capacity, such agreements can only serve as a temporary solution with limited scope. Fourth, demand management should be expanded to further mitigate supply bottlenecks; this tool will become more relevant in the coming years as nuclear and coal power is phased out.

The necessary move away from coal-fired power generation to renewable energy poses major challenges for all countries worldwide. Germany was one of the first countries to formulate ambitious national goals for its energy transition. Today, it can be said that Germany will miss most of its energy-transition targets for 2020. However, energy transition remains a process. To get back on track now, the federal government needs to put the recently announced climate program into action, in an effective and timely manner, and it needs to consider further measures. There is still a chance for Germany to remain a pioneer in climate protection. And, there is an external "motivation" for the country to succeed: based on current EU regulation, the country could be obliged to make compensation payments if EU targets are breached continuously. Already, in the federal budget for 2020 to 2022, €300 million has been reserved for the purchase of missing CO₂ pollution rights from other EU states. The energy think tank Agora estimates that penalties could add up to €30 billion to €60 billion over the next decade. That's money taxpayers would have to spend if no countermeasures are taken.

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