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Article

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Electricity Grids and Climate Targets: New Approaches to Grid Planning

By Robert Mieth, Richard Weinhold, Clemens Gerbaulet, Christian von Hirschhausen and Claudia Kemfert

Grid optimization, capacity increases, and grid expansion all play a key role in the development of the German power generation system. Thanks to transmission system operators' foresightedness with regard to grid investments, transmission expansion has not been an obstacle for Germany's energy transition to date. So far, grid expansion planning already accounted for German renewable energy targets, the nuclear phase-out, and the European Emissions Trading System. From now on, the planning framework also includes scenarios which explicitly account for German emissions reduction targets. The level of CO₂ emissions from power stations is to be cut to 187 million tons and 134 million tons by 2025 and 2035, respectively, compared with 317 million tons in 2013. Unlike last year's version of the scenario framework, the latest draft put forward by transmission system operators included a significant increase in lignite-based power generating capacities. In contrast, the version that has now been approved by the German government contains specifications for lignite-based power generation which, depending on the scenario, are five to seven gigawatts lower than the values set down in the draft.

Since 2011, development plans for the electricity transmission system in Germany have been drawn up in a newly structured iterative process involving both transmission system operators and the German Federal Network Agency (*BNetzA*), subject to regular public consultation procedures.¹ Every three years at the least, the annual Grid Development Plan (in German, *Netzentwicklungsplan*, NEP) is taken as the foundation for grid requirements planning in accordance with the Federal Requirement Plan Act (*Bundesbedarfsplangesetz*). This in turn is based on the draft scenario framework put forward by the transmission system operators, which contains various development scenarios for power generation capacities using different technologies as well as for electricity demands for a period of ten to fifteen years. Despite the increased transparency provided by the new process in comparison to previous approaches to grid planning, it, too, has been criticized.

The inclusion of climate target considerations in grid development plans has been the subject of recent debate. The authors of the present report, however, have long since stressed that grid expansion should not only be about securing supply but should also serve to help meet climate targets.²

So far, renewable energy targets and a moderate CO₂ price from the European Emissions Trading System (ETS) have already been reflected in the planning pro-

¹ For details of the public consultation process, see "Neuer institutioneller Rahmen der Netzplanung" in C. Gerbaulet et al., *Netzsituation in Deutschland bleibt stabil*, DIW Wochenbericht, no. 20+21 (Berlin: 2013): 4.

² See the joint statement by DIW Berlin and the Department for Economic and Infrastructure Policy of the TU Berlin: R. Ihlenburg et al., *Stellungnahme zum Szenariorahmen 2025 des Netzentwicklungsplan Strom 2015* dated April 30, 2014 (Berlin: 2014): 4. See also L. Jarass, "Stromnetzausbau für erneuerbare Energien erforderlich oder für unnötige Kohlestromeinspeisung?", *EweRK, Zeitschrift für Energie- und Wettbewerbsrecht*, no. 6 (Nomos: 2013), as well as F. Flachsbarth et al., "Ein Netz für die heutige Welt oder für die Welt von morgen? Kommentierung des Szenariorahmens 2015," *Öko-Institut* (Freiburg: 2014): 7.

cess.³ The current 2015 scenario framework, which was approved by the Federal Network Agency on December 19, 2014, now includes, for the first time, scenarios which explicitly consider the German government's targets for CO₂ emissions reductions for the energy sector. Unlike previous scenario frameworks, this version anticipates a faster phase-out of lignite-based power generation.

The modifications made by the Federal Network Agency are to be seen in the context of the current debate on energy policy in Germany. The government recently re-confirmed its commitment to cut greenhouse gas emissions in Germany by 40 percent over the reference year 1990. Its Climate Agenda 2020 sets down specific targets for CO₂ emissions reductions which are to be met by 2020; exactly how this will be achieved has yet to be specified.⁴

Energy Transition So Far Not Hindered by Grid Expansion

In connection with network development planning, it is often claimed that the speed of grid expansion defines that of the energy transition.⁵ Yet neither the latest studies nor Federal Network Agency statistics have given any indication to date that this might be the case.⁶ First, capacity increases, as well as grid optimization and expansion measures continue to be implemented.⁷ Neither grid expansion (new and additional lines) nor upgrades to existing and new power lines have been subject to any major delays. Many additional sections of transmission lines are already in the final project stages and are expected to be completed in the near future.⁸ The grid expansion plan is slightly behind schedule but will not impede the energy transition in the immediate future.

Second, over the past few decades, the German national grid, for reasons of historic development, was substantially expanded, such that, despite nuclear power phase-out and the increasing use of renewables, only minor re-dispatch measures were required. In 2013, the total intervention into power plant operation by transmission system operators amounted to 4.4 terawatt-hours;⁹ this is equivalent to less than one percent of the total amount of electricity produced in this year. The number refers to both power- and voltage-related measures as well as related counter-trading activities. Redispatch measures were carried out during 232 days of the year 2013 with an overall duration of 7965 hours. Total costs for national redispatch amounted to around 133 million Euro. For the most part, redispatch was carried out within the area operated by TenneT as well as the border region between TenneT and 50Hertz Transmission.¹⁰ Although detailed data for 2014 is not yet available, transmission system operators could also manage the grid situation in 2014 at all times, drawing on the established instruments.

Previous Scenario Frameworks and Network Planning with Large Share of Lignite-Based Power Generation

In the past, German grid development plans have foreseen extensive integration of lignite-fired power plants into the grid. Transmission system operators are legally obliged to provide a transmission grid that is able to cope with the market based dispatch as often as possible and to ensure reliable transport of that energy to end customers. This is said to facilitate and promote competition between the different power plant operators.

Owing to the extremely low prices for emissions allowances in recent years, the Emissions Trading System, the European Union's key tool for reducing CO₂ emissions, did not result in a shift away from lignite and hard coal toward the greener natural gas in Germany's energy sector. In fact, owing to their low power generating costs, lignite-fired power plants are almost invariably included in the market result, except for hours in which they are substituted by very high renewable feed-in. This is seen in the forecasts for 2024 resulting from transmission system operators' simulations.¹¹

³ The reform of the European Emissions Trading System is currently being discussed in the European Parliament; this reform is based on a proposal by the EU Commission which was then adopted by the European Council in October 2014.

⁴ See German Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety, Climate Agenda 2020 (Berlin: 2014): 28.

⁵ See the second draft 2014 Grid Development Plan: 120.

⁶ See Federal Network Agency monitoring reports, as well as F. Kunz et al., "Mittelfristige Strombedarfsdeckung durch Kraftwerke und Netze nicht gefährdet," DIW Wochenbericht, no. 48 (2013).

⁷ For example, the Power Grid Expansion Act (Gesetz zum Ausbau von Energieleitungen, EnLAG) passed in 2009 led to steps toward implementing more than 400 of 1,887 kilometers of power transmission lines.

⁸ See Federal Network Agency, EnLAG Monitoringbericht, Stand des Ausbaus nach dem Energieleitungsausbaugesetz (EnLAG) zum dritten Quartal 2014 (Berlin: 2014).

⁹ Bundesnetzagentur and Bundeskartellamt, „Monitoringbericht 2014.“ Bonn, 14.12.2014. See also <https://www.netztransparenz.de/de/Redispatch.htm>

¹⁰ Transmission system operator TenneT operates across an area stretching from Schleswig-Holstein and Lower Saxony to Hesse and Bavaria, while 50Hertz Transmission covers the northeastern region.

¹¹ See the second draft 2014 Grid Development Plan: 53.

Draft 2025 Scenario Framework Envisaged Higher Lignite Capacities

All the scenarios in the draft 2025 scenario framework¹² put forward by transmission system operators on April 30, 2014 forecasted an increase in lignite-based capacity over the 2014 Grid Development Plan. Scenario A of the Grid Development Plan 2025 even included the construction of two new lignite-fired power plants in North Rhine-Westphalia (Niederaußem) and Saxony-Anhalt (Profen).¹³ In addition, it was suggested that instead of assuming a service life of 50 years for all lignite-fired power plants across the board, the service life of these plants should instead be seen in relation to the duration for which open-cast mines have been approved. Compared to the values in the final approved scenario framework for the 2014 Grid Development Plan, this resulted in an increase in lignite-based capacity in the individual scenarios from 2.0 (scenario C) to 4.3 gigawatts (scenario A) for 2025, and 2.6 gigawatts for 2035 (see Figure 1). There was no consistent choice of power plant based on open-cast mine reserves and the assumptions made about extended service life were not comprehensible.

Approved Scenario Framework with Emissions Reduction Targets and Less Lignite

The 2025 scenario framework, approved by the Federal Network Agency on December 19, 2014 contains two new scenarios in addition to the four used to date (see Table 1). In three of the scenarios, steps taken by the electricity sector to help meet Germany's climate targets are to be taken into consideration explicitly. As in the past, there are essentially three scenarios for a time frame of ten years (i.e., 2025), A, B, and C, with scenario B updated to cover 20 years (2035) as well.¹⁴ What is new here is that development scenario B is shown in two versions, B1 and B2. In B1, the German government's climate targets will in all probability not be met. The B2 version, in contrast, contains mandatory emissions restrictions which are in line with the German government's emissions targets for the energy sector; in the three scenarios B2 2025, B2 2035, and C, the market simulations

¹² The draft proposal by transmission system operators is entitled Szenariorahmen für die Netzentwicklungspläne Strom 2015 (Scenario framework for grid development plans for electricity supply 2015). The version approved by the Federal Network Agency uses the title Szenariorahmen 2025 (2025 scenario framework).

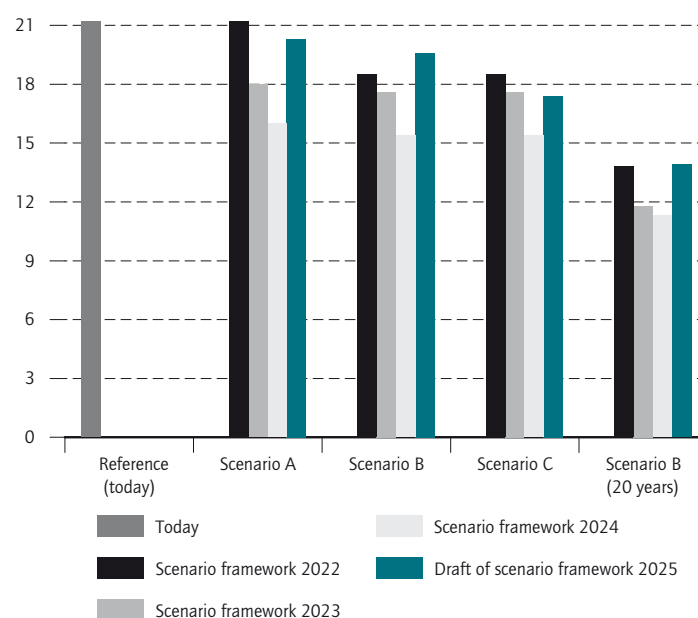
¹³ The power plant Profen was already included in the 2014 Grid Development Plan.

¹⁴ Under the third sentence of Section 12a (1) of the German Energy Industry Act (Energiewirtschaftsgesetz, EnWG), this describes the likely development in the next 20 years.

Figure 1

Lignite capacities in recent scenario frameworks

In gigawatts



Source: Bundesnetzagentur (Federal Network Agency).

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The draft of the scenario framework 2025 foresees high lignite capacities.

Table 1

Overview of the new scenario structure

	Scenario for year:	
	2025	2035
Without emission limit	A, B1	B1
With emission limit	B2, C	B2

Source: Bundesnetzagentur (Federal Network Agency).

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Scenario B is split up into two scenarios with and without emission limits.

conducted by transmission system operators in their requirements planning must include a secondary condition which takes CO₂ emissions caps into account—a maximum of 187 and 134 million tons of CO₂ for 2025 and 2035, respectively.

In comparison to the draft submitted by transmission system operators, the lignite capacities approved by the Federal Network Agency for the 2015 Grid Development Plan were almost five (B 2035) to seven (C 2025) gigawatts lower (see Figure 2); the latter equates to a third

Table 2

List of lignite power plants in the confirmed scenario framework 2025

BNetzA-ID	Plant Name	Block Name	State	Commissioning (Year)	Net Capacity [MW]	Net capacity in the confirmed scenario framework [MW]			
						Scenario A 2025	Scenarios B1 / B2 2025	Scenario C 2035	Scenarios B1 / B2 2035
BNA0081	Klingenberg	Klingenberg	Berlin	1981	164	164	164	0	0
BNA0183	Schwarze Pumpe	A	Brandenburg	1999	74	74	74	74	74
BNA0785	Schwarze Pumpe	B	Brandenburg	1981	465	465	465	0	0
BNA0786	KW Jänschwalde	A	Brandenburg	1982	465	465	465	0	0
BNA0787	KW Jänschwalde	B	Brandenburg	1984	465	465	465	0	0
BNA0788	KW Jänschwalde	C	Brandenburg	1985	465	465	465	0	0
BNA0789	KW Jänschwalde	D	Brandenburg	1987	465	465	465	465	0
BNA0790	KW Jänschwalde	E	Brandenburg	1989	465	465	465	465	0
BNA0914	KW Jänschwalde	F	Brandenburg	1997	750	750	750	750	750
BNA0915	HKW Cottbus	1	Brandenburg	1998	750	750	750	750	750
BNA0439	Buschhaus	D	Lower Saxony	1985	352	352	352	0	0
BNA0292	BoA 2	Neurath F	North Rhine-Westphalia	1959	118	0	0	0	0
BNA0313	BoA 3	Neurath G	North Rhine-Westphalia	1966	284	0	0	0	0
BNA0314	Niederaußem	A	North Rhine-Westphalia	1970	278	0	0	0	0
BNA0489	Niederaußem	B	North Rhine-Westphalia	1992	66	0	0	0	0
BNA0490	Niederaußem	G	North Rhine-Westphalia	1993	85	0	0	0	0
BNA0491	Niederaußem	H	North Rhine-Westphalia	1991	52	52	52	52	52
BNA0543	Niederaußem	K	North Rhine-Westphalia	2010	75	75	75	75	75
BNA0696	Neurath	A	North Rhine-Westphalia	1972	277	0	0	0	0
BNA0697	Neurath	B	North Rhine-Westphalia	1972	288	0	0	0	0
BNA0698	Neurath	C	North Rhine-Westphalia	1973	292	0	0	0	0
BNA0699	Neurath	D	North Rhine-Westphalia	1975	607	0	0	0	0
BNA0700	Neurath	E	North Rhine-Westphalia	1976	604	604	0	0	0
BNA0705	Weisweiler	G	North Rhine-Westphalia	1968	297	0	0	0	0
BNA0706	Weisweiler	H	North Rhine-Westphalia	1971	299	0	0	0	0
BNA0707	Weisweiler	E	North Rhine-Westphalia	1974	648	0	0	0	0
BNA0708	Weisweiler	F	North Rhine-Westphalia	1974	653	0	0	0	0
BNA0709	Niederaußem	F	North Rhine-Westphalia	2002	944	944	944	944	944
BNA0710	Niederaußem	D	North Rhine-Westphalia	1963	125	0	0	0	0
BNA0711	Niederaußem	E	North Rhine-Westphalia	1963	125	0	0	0	0
BNA0712	Niederaußem	C	North Rhine-Westphalia	1965	294	0	0	0	0
BNA0713	Frimmersdorf	P	North Rhine-Westphalia	1970	295	0	0	0	0
BNA1025	Frimmersdorf	Q	North Rhine-Westphalia	1965	312	0	0	0	0
BNA1026	Frechen/Wachtberg	Frechen/Wachtberg	North Rhine-Westphalia	1967	304	0	0	0	0
BNA1027	Goldenberg	F	North Rhine-Westphalia	1974	592	0	0	0	0
BNA1028	HKW Merkenich	Block 6	North Rhine-Westphalia	1975	592	0	0	0	0
BNA1401a	Goldenberg	E	North Rhine-Westphalia	2012	1 050	1 050	1 050	1 050	1 050
BNA1401b	Ville/Berrenrath	Ville/Berrenrath	North Rhine-Westphalia	2012	1 050	1 050	1 050	1 050	1 050
BNA0115	Lippendorf	R	Saxony	2000	875	875	875	875	875
BNA0116	Braunkohlekraftwerk Lippendorf	LIP S	Saxony	1999	875	875	875	875	875
BNA0122	Boxberg	N	Saxony	1979	465	465	0	0	0
BNA0123	Boxberg	P	Saxony	1980	465	465	0	0	0
BNA0124	Boxberg	Q	Saxony	2000	857	857	857	857	857
BNA1404	Boxberg	R	Saxony	2012	640	640	640	640	640
BNA0177	HKW Chemnitz Nord II	Block B	Saxony	1988	57	57	57	57	0
BNA0179	HKW Chemnitz Nord II	Block C	Saxony	1990	91	91	91	91	0
BNA0196	Schkopau	A	Saxony-Anhalt	1936	67	0	0	0	0
BNA0878	Schkopau	B	Saxony-Anhalt	1996	450	450	450	450	450
BNA0879	Deuben		Saxony-Anhalt	1996	450	450	450	450	450
	Plants < 50 MW				428	351	302	278	244
	Sum				21 206	14 231	12 648	10 248	9 136

Source: Bundesnetzagentur (Federal Network Agency).

Some big plants operating today are no longer considered in the scenario framework.

of the total installed lignite-based generating capacity in Germany. One reason for this decrease is that the Federal Network Agency rejected the transmission system operators' proposal to calculate the service life of power plants on the basis of the periods for which open-cast mines have been approved.¹⁵ Accordingly, lignite-fired power plants were removed from the list of power plants: all plans to build new power plants in Profen and Niederaußem in scenario A 2025 were abandoned and the service life of existing lignite-fired power plants reduced significantly (see Table 2).

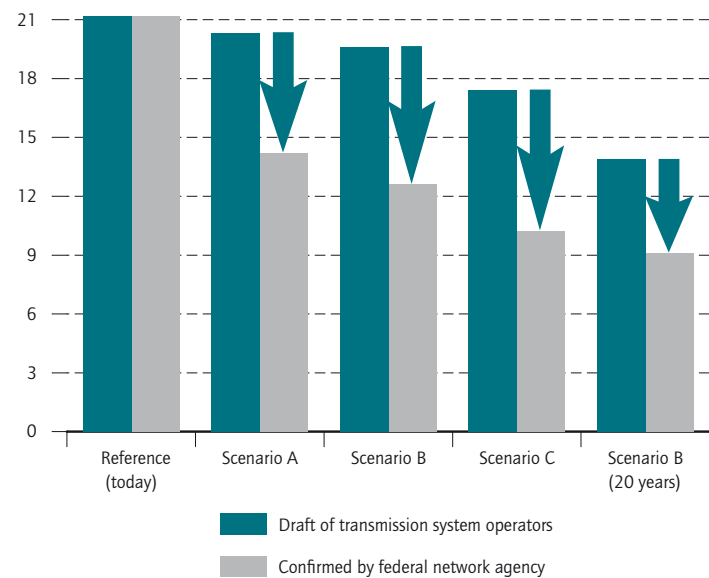
In light of this, the opening of new open-cast lignite mines, a decision justified by the need for lignite-based power generation, takes on new meaning, be it for the open-cast mining projects Jänschwalde-Nord, Welzow-Süd II, and Nochten II (Lausitz), Lützen and Pödelwitz in central Germany, or for the downsizing of the Garzweiler II open-cast mine in North Rhine-Westphalia.

In addition, according to the Federal Network Agency, future grid expansion planning in Germany will include capping methods that will apply an approximately three-percent cap to the rollout from onshore wind farms and solar power installations. This is in keeping with the provisions set down in the Ministry for Economic Affairs and Energy's Green Paper on the future development of the German electricity market, which underlines the lack of economy in expanding the national grid to accommodate "every last kilowatt hour of power generated."¹⁶

In the 2025 scenario framework approved by the Federal Network Agency, the agency used its regulatory powers to bring grid development in line with statutory provisions and social objectives for Germany's energy transition. For Germany's energy transition to be a success, grid development planning cannot be seen as an isolated entity—the acceptance of this is instrumental for the future of Germany's energy sector. In the medium term, further changes are needed in the methods used in grid development planning. This particularly means

Figure 2

Lignite capacities in the confirmed scenario framework 2015 In gigawatts



Source: Bundesnetzagentur (Federal Network Agency).

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Lignite capacities were reduced by five to seven gigawatts depending on the scenario.

better harmonization with similar planning processes in Germany's neighboring countries.

Conclusion

In their draft 2025 scenario framework, transmission system operators proposed an increase in lignite capacities over the 2014 Grid Development Plan; the reasoning behind this is new investments and also the fact that local lignite-based power generation is closely tied to available lignite reserves in Germany's open-cast mines. This was not consistent with the German government's target for the energy sector to cut CO₂ emissions by 40 percent over the reference year 1990 by 2020.

In contrast to the transmission system operators' draft, the 2025 scenario framework adopted by the Federal Network Agency on December 19, 2014 foresees substantially lower lignite capacities. In addition, it specifies emissions reduction constraints for three different scenarios for the transmission system requirements planning within the market simulation. According to these constraints, CO₂ emissions are limited to a maximum of 187 million tons and 134 million tons for 2025 and 2035, respectively. This would explicitly factor in

¹⁵ "Zudem ist die Wirtschaftlichkeit von Braunkohlekraftwerken im gegenwärtigen Marktdesign zumindest zu hinterfragen." (Engl.: "In addition, in today's market design, the efficiency of lignite-fired power plants is highly questionable.") See Genehmigung Szenariorahmen 2025, Ref.:6.00.03.05/14-12-19, Szenariorahmen 2025 (Berlin: Federal Network Agency, 2014): 67.

¹⁶ See German Federal Ministry for Economic Affairs and Energy (BMWi) (2014): 27. At the moment, however, it is not yet possible to adopt this option actively into current grid development planning, since the provisions set forth in Sections 8, 11, and 12 of the German Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG) state that transmission system operators must ensure that their networks have sufficient capacity to transmit, at any given time, the entire output from regenerative power generation. See Genehmigung Szenariorahmen 2025, Ref.:6.00.03.05/14-12-19, Szenariorahmen 2025 (Berlin: Federal Network Agency, 2014): 67.

the CO₂ emissions targets of the German government for the energy sector.

The German network planning process will continue to draw on iteratively evolving scenario frameworks and respective Grid Development Plans, which result in a Federal Requirement Plan Act at least every third

year. Actual planning and administration procedures should always be based on the latest Grid Development Plan, which currently is the NEP 2014. Actual changes in the scenario framework will be considered in the NEP 2015, which is to be approved by late 2015. The next revision of the Federal Requirement Plan is scheduled for 2016.

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