Bundesnetzagentur

Establishing requirements 2017-2030

Summary of consultation results

DECEMBER 2017

Publisher's details

Published by
Bundesnetzagentur für Elektrizität, Gas,
Telekommunikation, Post und Eisenbahnen
Tulpenfeld 4, 53113 Bonn
Tel.: +49 228 14-0
Fax.: +49 228 14-8872
info@netzausbau.de
www.netzausbau.de

As of
December 2017

Photo credits
Bundesnetzagentur für Elektrizität, Gas,
Telekommunikation, Post und Eisenbahnen,
©Volker Schlichting/123rf.com

Summary of consultation results

As of: December 2017

Contents

Introduction

Rund Some 15,000 responses were received after our provisional findings on the network development plans (NDPs) of the transmission system operators (TSOs) and on our draft environmental report were put up for consultation. The majority of responses, some 98 percent, came from private persons, mostly in the Coburg area.

An issue that continued to dominate was the possible risks of power lines to humans and human health.

But also the effects of power lines on the landscape and fauna were concerns that were often voiced.

More or less on a par with the above is the aspect of existing detriment. If a region already has infrastructure in the form of motorways, railway lines and power lines, residents then view a possible further power line as harmful to their environment.

All the responses were recorded and evaluated and the arguments put forward considered in terms of their importance to the decision-making process. In addition, the Bundesnetzagentur held information events in five German cities to raise awareness. Not every response and every argument has led to a specific change. Arguments put forward and questions raised in the consultation that do not refer to the level of the network development planning or are otherwise of a general nature are dealt with separately in a list of questions that can be viewed at *www.netzausbau.de/faq*.

The Bundesnetzagentur therefore wishes to thank all who took part in the consultation for their many tips and proposals.

Approval of the network development plans does not mean that grid expansion is complete, however. The plans are drawn up anew on a regular basis and put up for consultation anew. We want to hear your views in the next process, too, so that you can play a part in shaping Germany's energy reforms.

On the network development plans

All the grid expansion measures already included in the federal requirements plan have, upon renewed study, shown themselves still to be necessary. Thus the Bundesnetzagentur has given them fresh confirmation.

A new feature is the Bundesnetzagentur's confirmation of so-called ad hoc measures. These are grid expansion measures that can be implemented relatively quickly and that will help to lower the cost of intervention, for control purposes, in the grid during a transition period.

Altogether, the Bundesnetzagentur has confirmed 96 measures. The transmission system operators had proposed 165. It is possible that the federal requirements plan will combine several measures to comprise one infrastructure project.

From the Bundesnetzagentur's point of view, the legislature should incorporate 16 of the newly confirmed projects in the NDP 2017-2030 in the federal requirements plan as soon as possible, since these projects are necessary and sustainable no matter what direction is taken in future.

Various options are possible for Projects P43 and P44 in terms of both network technology and environmental impact. The legislature may, however, include additional aspects in its considerations. For this, the Bundesnetzagentur will supply all the currently available information on an open-outcome basis.

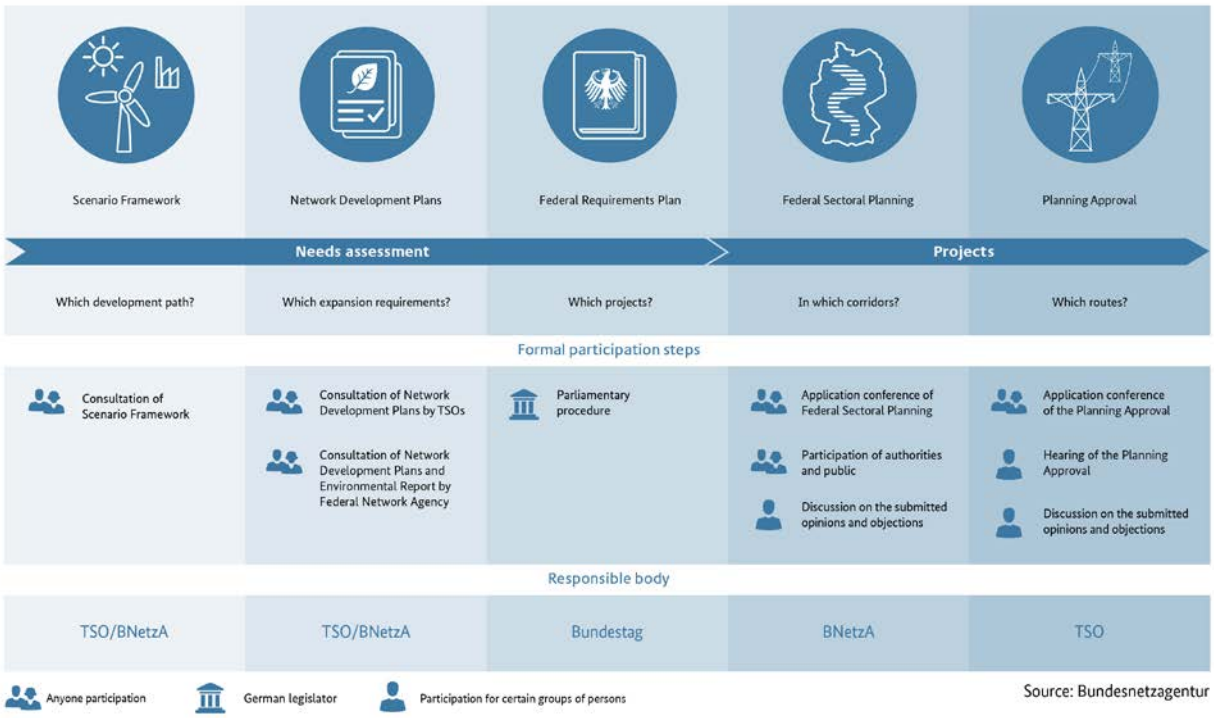
On the environmental report

The Bundesnetzagentur has studied considerably more project-specific alternatives in the current environmental report than in the preceding one: 51 as opposed to 15.

Furthermore, all the networks presented by the transmission system operators building on the three different scenarios of the scenario framework have undergone an assessment of alternatives. The feedback in the consultation on this comprehensive assessment was most positive.

Overall procedure

Figure 1: Five steps to grid expansion



The intention is to expedite the necessary nationwide expansion of the electricity grid. To this end, the country's requirements for the extra-high voltage networks are regularly studied and identified. This is done in a transparent process involving five steps which follow each other logically, and with broad-based public participation. Our aim is to equip the electricity grid for the transition to renewables as rapidly as possible, taking the necessary decisions together with the local communities.

1. Scenario framework

How much electricity will we consume in the coming years? What part will coal-fired and wind power stations play in future? Possible answers are provided by the scenario framework, which is drawn up regularly by the transmission system operators. This describes probable developments in the German energy landscape, and is created jointly by the four transmission system operators Amprion, Transnet-BW, 50Hertz and TenneT. The Bundesnetzagentur invites the public to submit views on the TSOs' draft. It then modifies the scenario framework in line with well-founded proposals from the public consultation or as a result of its own insights. Only then does it approve the scenario framework.

2. Network development plans

The TSOs, building on the scenario framework, then draw up a network development plan (NDP). This establishes the expansion requirements in the transmission network and contains the measures needed to optimise, reinforce and expand the electricity grid in line with requirements. It applies to the whole of the federal territory. In addition to the onshore NDP, the TSOs draw up an NDP for the North and the Baltic Seas as well, the so-called offshore network development plan (O-NDP). This specifies the requirements for the connections for the offshore wind farms. It also determines the order in which the connections will be built. The Bundesnetzagentur examines the measures proposed in terms of their necessity for the energy supply. Citizens, associations and public authorities can state their positions on the NDP and the O-NDP in multiple participation rounds.

Besides examining the NDP / O-NDP the Bundesnetzagentur identifies, describes and evaluates the likely significant environmental effects in a strategic environmental assessment (SEA). This first SEA in the process serves as a kind of early warning system: it is designed to identify potential conflicts with justified concerns for the protection of persons and nature right at the beginning of the process and, consequently, to mitigate them as effectively as possible or, best of all, to prevent them completely.

The findings are captured in an environmental report. The environmental report is then put up for consultation in parallel with the revised NDP and O-NDP.

3. Federal requirements plan

The confirmed network development plans and the environmental report together provide the basis for the federal requirements plan. This contains a list of projects for the power lines needed. The Bundesnetzagentur submits the draft federal requirements plan to the federal government at regular intervals. The government can then start the legislative process, at the end of which the necessity of the projects in terms of energy supply is established in the Federal Requirements Plan Act.

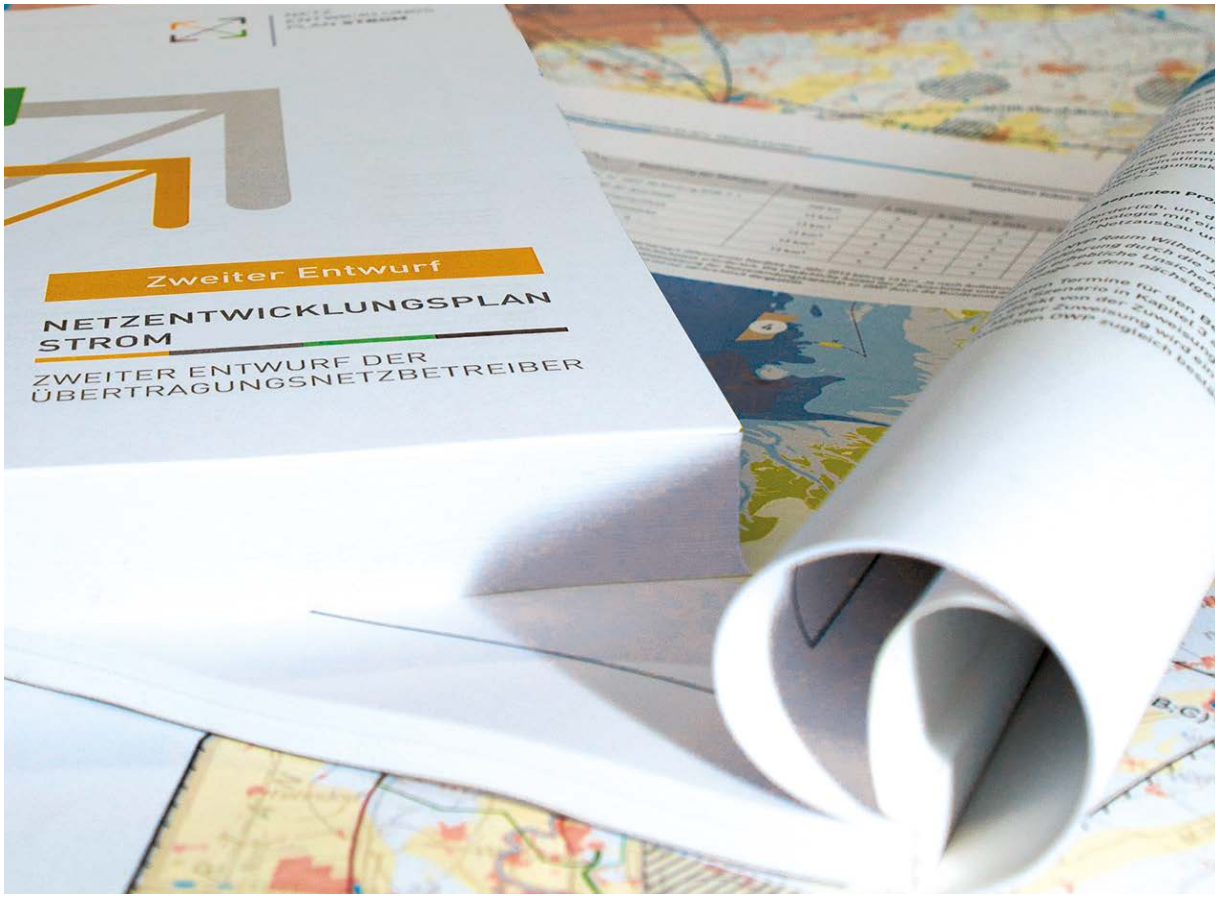
4. Federal sectoral planning

In the next step the transmission system operators propose the so-called route corridor, with alternatives, through which a new extra-high voltage line is to run.

For projects that do not cross any federal state borders a spatial planning procedure is undertaken by the federal state concerned. If, on the other hand, a line is marked as transregional or as transboundary in the Federal Requirements Plan Act, the Bundesnetzagentur carries out what is known as a federal sectoral planning procedure for it.

5. Planning approval

Planning approval is based on the route corridors put forward in the fourth step of the process. It is in this step that the exact route of the transmission line is determined. Yet alternative routes must also be considered. The transmission system operators' proposals are studied for, amongst other things, their effects on humans and the environment. Ultimately, a decision is taken approving a route that promises the minimum negative disturbance.



A. Summarised account of the consultation

1.1 Introduction

Over the consultation period the Bundesnetzagentur received some 15,000 responses. The respondents were ministries, federal and federal state authorities, associations, local authorities, districts, nature conservation and environmental protection associations and individuals. The responses came in by post, by email and via a special online form.

Institutions1 and private persons supplied many important contributions, comments and advice that informed a hard look at the presentation and assessment of the documents put up for consultation. We took every response into account in checking the environmental report and confirming the network development plans. Even if not all the proposals, tips and comments in the responses occasioned a specific change, they were majorly important in terms of a critical study of the network development plans and the environmental report.

1.2 Statistical evaluation

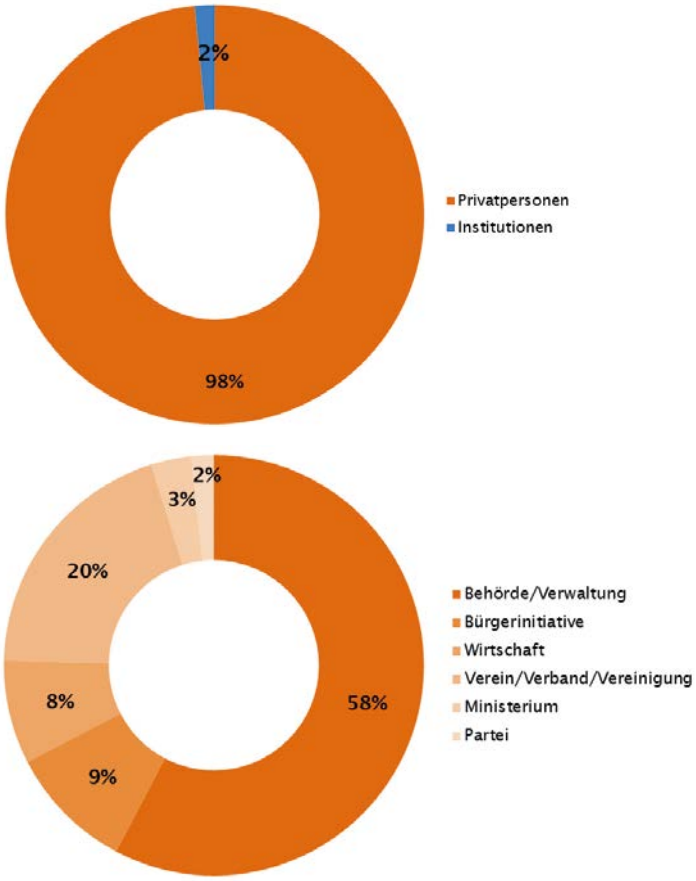
By far the majority of responses were received by post (93 percent). Email responses accounted for a vastly smaller share of 3percent only. New this time round was the possibility of responding via an online form. This was done in 4 percent of cases, resulting in a similar share to that of emails. Views from the same respondent reaching the Bundesnetzagentur by different means, for instance once by post and once by email, were taken into consideration once only per sender.

Of the responses received, 98 percent was accounted for by private persons and 2 percent by institutions. The views submitted by private persons came predominantly from the Coburg area (see Figure 2)..

The responses are available to the public on the Internet at *www.netzausbau.de*. However, the responses from private persons, citizens' action groups, associations, societies, unions and from trade and industry are published only if their authors have explicitly and unreservedly agreed to publication.

By contrast, all the responses from public authorities, ministries and parties are published provided they have not objected to publication. The responses can be viewed at *www.netzausbau.de/2030-archiv*.

Figure 1: Responses by respondent

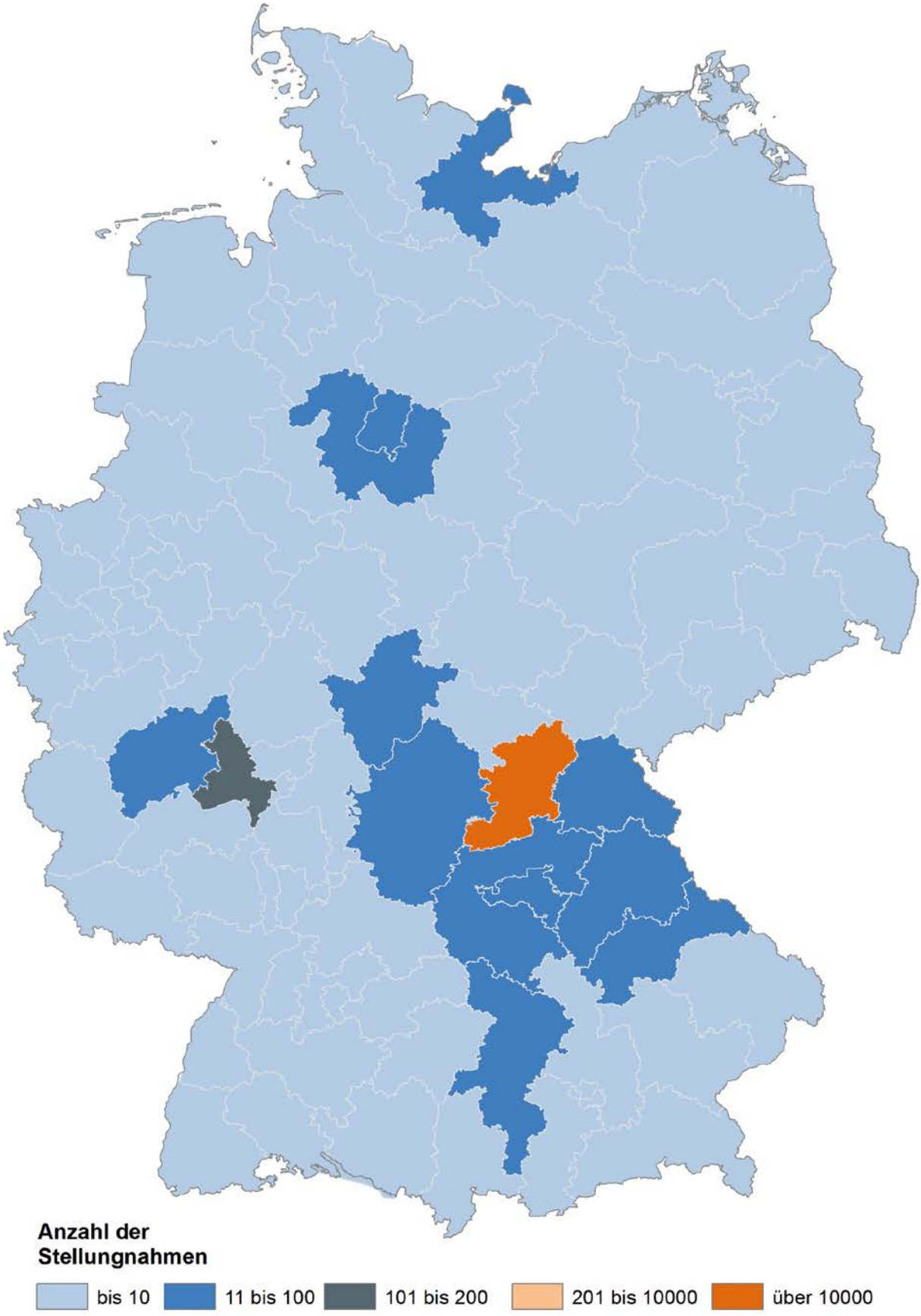


The Bundesnetzagentur notified the potentially affected neighbour states of the step in the process in which requirements were established, that is to say the examination of the NDP and the O-NDP and of the SEA. Subsequently, the Czech Republic initiated the participation of its own public authorities and general public, holding a consultation which ran from 23 October 2017 to 22 November 2017. In early December the Czech Environment Ministry then sent the Bundesnetzagentur 13 responses from public authorities, along with a cover letter.

The responses to the Electricity NDP 2017-2030 were primarily concerned with the form the energy transition would take and the matter of requirements. These and further points were taken up in the respective documents confirming the NDP and the O-NDP 2017-2030.

[1] Institution is used here as a blanket term for public authorities/administration, trade and industry, societies/federations/ associations, ministries, citizens' action groups and parties/trade unions. Citizens' action groups are recorded here only when they were cited as such.

Abbildung 2: räumliche Verteilung der Stellungnahmen



The environmental report is an account exclusively of the focal subjects of the consultation on the content and information in the environmental report.

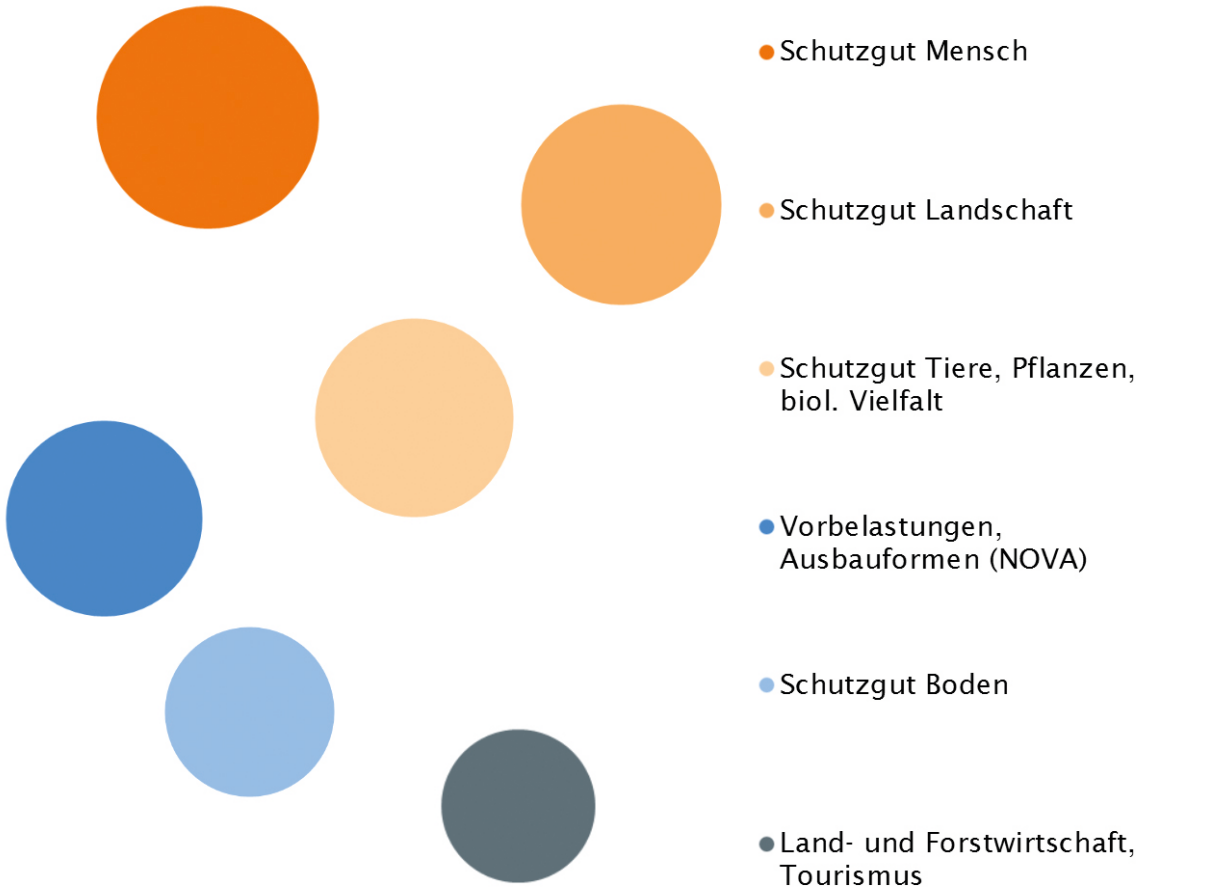
As in previous processes, in this round, too, a large number of the responses cited people and their need for protection. Respondents detailed the detriment to human health as a result of electrical and magnetic fields, safety clearances from lines and the impacts of sub-facilities such as converter stations.

Many comments were also made about the landscape and its need for protection. Here, the main concern was the visual impact of power lines. In this connection private persons, above all, feared negative consequences for leisure and recreation.

Likewise, mention was often made of fauna and flora and biodiversity, further assets for protection. Chiefly referred to was the impact on avifauna, the birds in the regions, that power line construction would cause.

Often, respondents also pointed out existing detriment in particular regions. Reference was mainly made here to the assessment of the environmental impact caused by the construction of more electricity lines. Many respondents also felt that an assessment of the environmental impact solely with regard to the construction of new lines and not differentiated according to the NOVA principle (network optimisation before reinforcement before new construction) was too general.

Abbildung 3: Verteilung der Themen



Also, much was written on soils as a protected asset. Reference was made, for instance, to locally occurring wetlands in relief terrain and to other types of soil that were potentially susceptible to compaction. Also voiced were concerns that would become relevant only at the later stages of federal sectoral planning and planning approval. These included, for instance, possible impacts on agriculture and forestry. Many farmers fear economic detriment as a result of masts being set up on agricultural land. Underground transmission cables and their impact on the ground structure are a further source of concern.

1.3 Modifications to the environmental report

How the Bundesnetzagentur has modified the environmental report to reflect the responses is described at the beginning of each chapter of the report.

But independently of these modifications, the Bundesnetzagentur has adapted the environmental report to bring it into line with the current stage of the process.

Definitively established now are the grid expansion measures in the Electricity NDP 2017-2030 and O-NDP 2017-2030 that the Bundesnetzagentur has confirmed. The revised environmental report therefore covers only the confirmed energy supply measures that are suitable for inclusion in the list of infrastructure projects in the Federal Requirements Plan Act (BBPlG).

Measures not currently confirmed by the Bundesnetzagentur and project-specific alternatives to these measures no longer feature.

In the revised environmental report the number of fact sheets at annex has therefore been matched to the confirmation figures. This has also given rise to modifications to the total area under assessment and to the statistical evaluation of the effects of the overall plan.

Finally, all the map data in the separate chapters and the annex have been aligned.

B Confirmation of the Electricity Network Development Plan 2017-2030

1. Methodology

The network development plan establishes the expansion requirements for the coming years. Determining what these expansion requirements are is based on the expected network load. Network areas with constant or diminishing loads will not need expansion. They do not need more transport capacity. Network areas with high transport requirements exceeding current transport capacity, on the other hand, must be optimised, reinforced or newly constructed in an adequate manner, taking account of the NOVA principle (network optimisation before reinforcement before new construction). The determinant of network load and hence of expansion requirements is feed-in and offtake from the transmission network in the reference year 2030. The requirements are identified in a multistage development process that is repeated at regular intervals and which is outlined in the following.

1.1 Scenario framework

Identifying the grid expansion requirements begins with drawing up the scenario framework. This framework describes various development pathways (scenarios) for future electricity generating capacity and consumption.

The basis for the NDP 2017-2030 is the Scenario Framework 2017-2030, which the Bundesnetzagentur approved on 30 June 2016. It features four scenarios. Three of these describe development pathways up to 2030, while the fourth sets out a scenario for the year 2035. All four scenarios meet the requirements of the Renewable Energy Sources Act (EEG) as amended in 2016.

Describing the scenarios in simple language, we would say that Scenario A is a "conservative" development pathway, whereas Scenarios B and C feature renewables to a greater extent. Scenario B is a "transformation" scenario, while Scenario C is an "innovation scenario". The scenario for 2035 looks at development over the longer term.

The individual scenarios differ in their assumptions of the speed and intensity of change in the energy landscape (see Table 1). In Scenario A 2030 conventional power plants continue to generate a large proportion of the energy, renewables are developed at a slower pace and the sectors integrated less intensively. In the innovation Scenario C 2030, by contrast, the network operators work on the assumption of faster development of renewables and greater energy integration.

Accordingly, Scenario A 2030 is the most conventional. A good 80 gigawatts (GW) of the generating capacity assumed comes from fossil fuels and other conventional plants; some 33 GW of this is accounted for by coal-fired power stations that operate in the energy market. In Scenario B 2030 on the other hand, the share of renewables increases, as does that of the gas-fired power plants, while only a good 24 GW is produced by coal. Finally, in Scenario C 2030 coal-fired power stations account for only just about 20 GW from installed producers.

In Scenarios B 2030, C 2030 and B 2035 conventional power plants may only produce to a degree that would not jeopardise the federal government's energy policy targets in respect of the reduction of greenhouse gas emissions.

New developments

The Network Development Plan 2017-2030 implements the key points of the amended Renewable Energy Sources Act (RES Act) for the first time. This has necessitated changes to, amongst other things, the expansion targets and the geographic distribution of the renewable energy generating facilities.

Network development planning takes available and competitive storage technologies into account to a realistic extent under energy supply and regulatory criteria (see Table 2). The requirements identified for the period 2017-2030 assume an increase in pumped storage capacity from 9.4 GW today to 11.9 GW. Battery-storage systems are included with a total capacity ranging from 3 to 6 GW, depending on the particular scenario.

Small combined heat and power (CHP) plants are included additionally to the large CHP plants, with a total capacity across the country of 8.4 GW, corresponding to that of several large power stations. This, too, means that decentralised production near to the place of consumption is taken into account realistically.

The grid can be used more efficiently if the loads are flexibilised. The requirements identified for the period 2017-2030 assume, depending on the particular scenario, controllable loads from trade and industry on a scale of two to six GW.

Network planning takes the integration of the electri-

city sector with the transport and the heat sector into account via the inclusion of electromobility and heat pumps. Yet it would be wrong to view integrated energy as no more than the capability of bringing relief to the grid and to see this effect only. The bottom line, namely, is that greater use of electrical energy in the transport and heat sectors entails a greater consumption of electricity. The fossil sources of energy previously used in these two sectors (petrol, diesel, oil, natural gas, coal) would have to be replaced by electricity.

Tabelle 1: Scenario Framework 2017-2030

Installed generating capacity (in gigawatt)					
Source of energy	**Reference 2015**	**Scenario A 2030**	**Scenario B 2030**	**Scenario C 2030**	**Scenario B 2035**
Nuclear	10,8	0,0	0,0	0,0	0,0
Brown coal	21,1	11,5	9,5	9,3	9,3
Hard coal	28,6	21,7	14,8	10,8	10,8
Natural gas	30,3	30,5	37,8	37,8	41,5
Oil	4,2	1,2	1,2	0,9	0,9
Pump storage	9,4	11,9	11,9	11,9	13,0
other (conventional)	2,3	1,8	1,8	1,8	1,8
Capacity reserve	0,0	2,0	2,0	2,0	2,0
Conventional	**106,9**	**80,6**	**79,0**	**74,5**	**79,3**
Wind onshore	41,2	54,2	58,5	62,1	61,6
Wind offshore	3,4	14,3	15,0	15,0	19,0
Photovoltaic	39,3	58,7	66,3	76,8	75,3
Biomass	7,0	5,5	6,2	7,0	6,0
Hydropower	5,6	4,8	5,6	6,2	5,6
other (renewable)	1,3	1,3	1,3	1,3	1,3
Renewable	**97,8**	**138,8**	**152,9**	**168,4**	**168,8**
Total	**204,7**	**219,4**	**231,9**	**242,9**	**248,1**
Net electricity consumption (in terawatt hours)					
	532,0	517,0	547,0	577,0	547,0
Peak load for the year (in gigawatt)					
	83,7	84,0	84,0	84,0	84,0

Treiber Sektorenkopplung (in Mio.)					
Wärmepumpen	0,6	1,1	2,6	4,1	2,9
Elektroautos	0,0	1,0	3,0	6,0	4,5
Flexibilitätsoptionen und Speicher (in Gigawatt)					
Power to Gas		1,0	1,5	2,0	2,0
PV-Batterie-speicher		3,0	4,5	6,0	5,0
DSM (Industrie und GHD)		2,0	4,0	6,0	5,0
Vorgaben zur Marktmodellierung					
			maximal 165 Mio. t CO_2	maximal 165 Mio. t CO_2	maximal 137 Mio. t CO_2

1.2 Regionalisation

The scenario framework provides data on generating capacity, energy consumption and annual peak load, aggregated for the country as a whole and broken down by energy source. A regional breakdown is needed for modelling the transport of electricity in future years in order to establish where what congestion will arise in the transmission network facilities in 2030. Here, specific location data are used – given their availability – especially for the smaller and easily set up renewables generating plants. But forecasting methods are also used to enable assignment to the individual nodes.

1.3 Market modelling

Following regional assignment to the individual transmission network nodes, the feed-in from the generators that is needed to cover future demand is established in a third step. This step is necessary so that the level of transport requirements and the demands this will make on the grid ten years on can be estimated.

Another important factor in market modelling is the weather. The weather affects the production of renewable wind and solar energy as well as anticipated demand in certain situations (eg lengthy periods of frost). To allow for this, a "historical" weather year (2012) is used as a basis for the modelling, in other words past experience.

Market simulation creates a model that details, down to the hour and network node, when and where in 2030 how much electricity will be generated and consumed or imported or exported. In other words it describes the transport operations the grid will need to handle.

1.4 Network planning

To plan the grid of the future, load flows are calculated for all the 8,760 hours of the year using the feed-in and load situations that market modelling has established. These calculations show the load on the grid and, with the aid of failure simulation, grid overload as well. The departure point for this is initially the start network. The start network comprises today's transmission network. It is augmented by measures that are already at a far advanced stage of planning or that are under construction and for which energy supply requirements have been identified, most notably by the Power Grid Expansion Act (EnLAG) or through planning approval.

It is on the basis of these analyses that the TSOs identify the grid expansion measures needed to maintain network security in the reference year 2030. These measures are identified as a general rule under the NOVA principle. This means that the transmission system operators, in the first instance, seek to optimise the grid, for instance by switching actions. Only when the potential for optimisation has been exhausted are re-

inforcement measures taken, for instance exchanging 220 kV for 380 kV wiring. When this potential, too, has been exhausted, grid expansion measures are then permitted, for instance the construction of new extra-high voltage lines.

In technical terms, expansion planning follows the planning principles of the transmission system operators. One such principle is unrestricted operation of the grid even in the event of the failure of individual facilities, also called n-1 security. Instruments providing flexible operation such as redispatch that have been available in the past as security back up, are not now considered. Later operation of the grid would face restrictions if network planning were to use such instruments. This would have unpredictable consequences for the historically high level of reliability of the German energy supply infrastructure.

The result of these network calculations then constitutes the grid expansion requirements required up to 2030 and 2035 which are then taken up by the transmission system operators in their network development plan.

2. Examination

Publication of the second draft of the network development plans marks the start of the Bundesnetzagentur's examination of the grid expansion measures proposed by the transmission system operators in their plans. The Bundesnetzagentur has confirmed those projects that meet the criteria of effectiveness and necessity or other considerations (cf sections 2.1ff). Of these projects, moreover, it has only confirmed those that have shown themselves to be robust in relation to changed framework conditions – after all, there is always some uncertainty involved in forecasting future developments. That said, measures not confirmed at present may well be regarded in the coming years as effective and necessary on account of changed framework conditions.

As a first step, the Bundesnetzagentur revisited all the measures in the Federal Requirements Plan Act to see whether they were still eligible for confirmation. Only then were remaining sources of congestion that occurred frequently in all the scenarios identified in the next step and the measures for their removal proposed by the transmission system operators studied.

2.1 Effectiveness

The criterion of effectiveness establishes whether a measure is needed in order to maintain security of operation in the modelled situation for the network of 2030. Studied therefore is the extent to which secure network operation is possible with, and without, this measure. To this end, in a model of the grid, the measure is first taken out or deactivated and the grid analysed. Subsequently the same analysis is carried out, this time with the measure considered. Both outcomes are then examined for prohibited operating states and overload.

Examination of the measures

a. Effectiveness

b. Necessity

If it is established that the measure under scrutiny can reduce, or even completely remove, the number of cases of overload and prohibited operating states it is judged effective. In line with the planning principles it suffices if the avoidance of overload occurs only in one particular instance of use, in other words solely in one hour in the year.

Additionally, there are measures whose effectiveness may result solely from other considerations. In these cases other indicators are consulted for an assessment. Thus some projects are justified only through the removal of overload at the underlying network levels. To test the effectiveness of these measures the data for the underlying 110 kV networks are examined.

Expansion of the transmission network can possibly avoid large-scale expansion in the underlying network so that expansion only of the underlying network is not a feasible option.

In the case of transboundary measures, the so-called interconnectors, their transboundary benefit is analysed. For this, analyses by the transmission system operators of the Europe-wide Ten Year Network Development Plan (TYNDP) are consulted in addition to external expert opinions. These analyses show the specific benefits and place the measures and their advantages in the European context.

2.2 Necessity

The Bundesnetzagentur, in examining how necessary a measure is, goes beyond the transmission system operators' planning criteria. In light of the existing imponderables a study of effectiveness is not enough to uphold proportionality and to comply with the Bundesnetzagentur's mandate of creating a sufficient basis for parliamentary confirmation of the need for

expansion in the form of a law.

The measures for which confirmation is required must therefore be sufficiently robust as well, that is to say they must generate sufficient benefit even under the most diverse conditions. Yet the capacity limits should not be set too high so as to be able to respond in the event of failure in later operation to operational shutdowns or other events. Ultimately, an indicator of robustness for the utilisation of a line in the range of 20 percent seems suitable. But this degree of utilisation indicates a borderline because below 20 percent utilisation, technically speaking, a 110 kV line could also come under consideration for handling the transport requirements.

3. Findings

The transmission system operators (TSOs) have proposed 160 measures for expansion of the transmission network. Of these, the Bundesnetzagentur has confirmed 96.

In their network development plans the TSOs propose that no additional high-voltage direct current (HVDC) lines be constructed before 2030. Instead, they are looking to reinforce the traditional alternating current connections or to construct new ones. They intend, moreover, to achieve better utilisation of the transmission network by using so-called power controlling elements.

Expansion of the alternating current network quite possibly depends on whether further HVDC lines are added in future. That is why the Bundesnetzagentur is in favour to begin with of confirming only those additional grid expansion projects that are feasible and sustainable at all events, irrespective of future technology decisions.

Table 3: Kilometre overview

	NDP 2017-2030 2nd draft (TSOs)	Confirmed	Not confirmed	For comparison: Fed Requirements Plan
AC new construction	550	400	150	350
DC new construction	2.150	2.150	-	2.150
DC interconnectors	100	100	-	50
AC reinforcement	5.750	3.400	2.350	2.550
AC-/DC conversion	300	300	-	300
				Meanwhile in the start network: 500
Total	**8.850**	**6.350**	**2.500**	**5.900**

Divergences from the lengths in the TSOs' drafts also arise because the Bundesnetzagentur disregards from the outset what the TSOs designate as "measures not worthy of proposal".

Table 4: Number of measures (incl. network point and ad hoc measures)

	Total	Confirmed	Not confirmed
Draft NDP 2017-2030 Entwurf (TSOs)	165	96	69
of these Fed Requirements Plan	60	60	-

Table 5: List of confirmed measures

Project	Measure	Grid connection points	Type	Project according to BBPlG 2015*
DC1	DC1	Emden/Ost – Osterath	Line	1
DC2	DC2	Osterath – Philippsburg	Line	2
DC3	DC3	Brunsbüttel – Großgartach	Line	3
DC4	DC4	Wilster – Bergrheinfeld	Line	4
DC5	DC5	Wolmirstedt – Isar	Line	5
P20	M69	Emden/Ost – Halbemond	Line	37
P21	M51a	Conneforde – Cloppenburg	Line	6
P21	M51b	Cloppenburg – Merzen	Line	6
P23	M20	Dollern – Elsfleth/West	Line	38
P24	M71a	Stade – Dollern	Line	7
P24	M71b	Dollern – Sottrum	Line	7
P24	M72	Sottrum – Grafschaft Hoya	Line	7
P24	M73	Grafschaft Hoya – Landesbergen	Line	7
P25	M44	Husum/Nord – Klixbüll/Süd	Line	8
P25	M45	Klixbüll/Süd – Bundesgrenze (DK)	Line	8
P33	M24a	Wolmirstedt – Helmstedt – Hattorf – Wahle	Line	10
P33	M24b	Wolmirstedt – Helmstedt – Hattorf – Wahle	Line	10
P34	M22a	Perleberg – Stendal/West – Wolmirstedt	Line	39
P34	M22b	Parchim/Süd – Perleberg	Line	39
P34	M22c	Güstrow – Parchim/Süd	Line	39
P36	M21	Bertikow – Pasewalk	Line	11
P37	M25a	Vieselbach – PSW Talsperre Schmalwasser (Punkt Sonneborn)	Line	12
P37	M25b	PSW Talsperre Schmalwasser (Punkt Sonneborn) – Mecklar	Line	12
P38	M27	Pulgar – Vieselbach	Line	13

*The grid connection points listed here are not worded identically in the Federal Requirements Plan Act, BBPlG 2015. How they are assigned serves orientation purposes only. Some of the designations differ due to the advanced stage of planning..

Table 5: List of confirmed measures

Project	Measure	Grid connection points	Type	Project according to BBPlG 2015*
P39	M29	Röhrsdorf – Weida – Remptendorf	Line	14
P43*	M74a	Mecklar – Dipperz	Line	17
P43*	M74b	Dipperz – Bergrheinfeld	Line	17
P43mod*	M74mod	Mecklar – Dipperz – Urberach	Line	-
P44*	M28a	Schalkau – Landesgrenze Thüringen/Bayern	Line	-
P44*	M28b	Landesgrenze Thüringen/Bayern – Grafenrheinfeld	Line	-
P44mod*	M28b mod	Landesgrenze Thüringen/Bayern – Würgau – Ludersheim	Line	-
P44mod*	Variante 2	Altenfeld – Remptendorf – Würgau – Ludersheim	Line	-
P44mod*	Variante 2+	Remptendorf – Würgau – Ludersheim	Line	-
P44mod*	Variante 3	Altenfeld – Remptendorf – Mechlenreuth	Line	-
P44mod*	Variante 4	Altenfeld – Redwitz – Mechlenreuth	Line	-
P46	M56	Redwitz – Mechlenreuth – Etzenricht – Schwandorf	Line	18
P47	M31	Weinheim – Daxlanden	Line	19
P47	M32	Weinheim – G380	Line	19
P47	M33	G380 – Altlußheim	Line	19
P47	M34	Altlußheim – Daxlanden	Line	19
P47	M60	Urberach – Pfungstadt – Weinheim	Line	20
P48	M38a	Grafenrheinfeld – Kupferzell	Line	20
P48	M39	Kupferzell – Großgartach	Line	20
P49	M41a	Daxlanden – Kuppenheim – Bühl – Weier – Eichstetten	Line	21
P50	M41	Oberjettingen – Engstlatt	Line	-
P50	M366	Pulverdingen – Oberjettingen	Line	-
P52	M93	Punkt Rommelsbach – Herbertingen	Line	24

** In Project P43 each variant is eligible for confirmation in itself. Upon realisation of one of the variants the other variants lapse. The same applies to Project P44.

Table 5: List of confirmed measures

Project	Measure	Grid connection points	Type	Project according to BBPlG 2015*
P52	M94b	Punkt Neuravensburg –Bundesgrenze (AT)	Line	40
P52	M95	Punkt Wullenstetten – Punkt Niederwangen	Line	25
P53	M54	Raitersaich – Ludersheim	Line	41
P53	M350	Ludersheim – Sittling – Altheim	Line	41
P56	M503a	Zweites Dreibein Brunsbüttel	Plant	-
P64	M107	Combined Grid Solution (CGS)	Line	29
P65	M98	Oberzier – Bundesgrenze (BE)	Line	30
P66	M101	Wilhelmshaven – Conneforde	Line	31
P67	M102	Simbach – Bundesgrenze (AT)	Line	32
P67	M103a	Altheim – Adlkofen	Line	32
P67	M103b	Adlkofen – Matzenhof	Line	32
P69	M105	Emden/Ost – Conneforde	Line	34
P70	M106	Birkenfeld – Mast 115A	Line	35
P72	M50	Kreis Segeberg – Lübeck	Line	42
P72	M351	Lübeck – Göhl	Line	42
P72	M49	Lübeck – Siems	Line	42
P112	M201	Pleinting – Bundesgrenze (AT)	Line	32
P112	M212	Abzweig Pirach	Line	32
P113	M519	Stadorf/Wahle	Plants	-
P115	M205	Mehrum	Plant	-
P118	M207	Borken – Mecklar	Line	43
P133	M253 PST	Lastflusssteuernde Maßnahme in Borken	Plant	-
P150	M352a	Querfurt – Wolkramshausen	Line	44
P151	M353	Borken – Twistetal	Line	45
P154	M356 TR1	Siegburg	Plant	-

P155	M357	Elsfleth/West	Plant	-
P161**	M91	Großkrotzenburg – Urberach	Line	-
P170	M380	Uchtelfangen – Ensdorf – Bundesgrenze (FR)	Line	-
P176	M387	Eichstetten – Bundesgrenze (FR)	Line	-
P180	M406	Marzahn – Friedrichshain – Mitte – Charlottenburg – Reuter – Teufelsbruch	Line	-
P185	M420	Redwitz – Landesgrenze Bayern/Thüringen (Punkt Tschirn)	Line	46
P200	M425	Punkt Blatzheim – Oberzier	Line	-
P204	M430	Tiengen – Bundesgrenze (CH)	Line	-
P206	M417	Abzweige Kreis Konstanz und Beuren	Lines	-
P215	M454	Bentwisch – Güstrow	Line	-
P215	M521	Bentwisch-Sanitz/Dettmannsdorf	Line	-
P216	M455	Güstrow – Siedenbrünzow – Alt Tellin/Bartow – Iven	Line	-
P216	M523	Iven – Pasewalk/Nord – Pasewalk	Line	-
P221	M460	Güstrow – Südschweden (Hansa PowerBridge)	Line	-
P222	M461	Oberbachern – Ottenhofen	Line	47
P224	M463	Wolkramshausen – Ebeleben – Vieselbach	Line	44
P310	M485	Bürstadt – Kühmoos	Line	-
P313	M488	Dahlem – Bundesgrenze (BE)	Line	-
P314	M489	Load flow management measure in the Saarland	Plant	-
P315	M491	Hanekenfähr – Gronau	Line	-
P327	M522	Load flow management measure in the Ruhrgebiet	Plant	-
P333	M553	Eichstetten – Kühmoos	Line	-

** Project P161 can be dropped if variant M74mod is realised in Project P43.

Table 5: List of confirmed measures

Project	Measure	Grid connection points	Type	Project according to BBPlG 2015*
P333	M554	Eichstetten – Schwörstadt	Line	-
P333	M555	Schwörstadt – Kühmoos	Line	-
P345	M556	Load flow management measure in Hamburg/Ost	Plant	-
P346	M557	Load flow management measure in Hanekenfähr	Plant	-
P347	M558	Load flow management measure in Oberzier	Plant	-
P348	M559	Load flow management measure in Wilster	Plant	-
P349	M560	Load flow management measure in Würgau	Plant	-
P350	M561	Load flow management measure in Pulverdingen	Plant	-

Table 6: List of non-confirmed measures

Project	Measure	Grid connection points	Type	Project according to BBPlG 2015
P22	M80	Elsfleth/West – Ganderkesee	Line	-
P22	M82	Conneforde – Unterweser/West	Line	-
P22	M87	Unterweser/West – Elsfleth/West	Line	-
P26	M76	Büttel – Wilster/West	Line	-
P26	M79	Elbekreuzung	Line	-
P26	M89	Wilster/West – Dollern	Line	-
P26	M432	Brunsbüttel – Büttel	Line	-
P27	M52	Landesbergen – Ohlensehlen – Wehrendorf	Line	-
P27	M506b	Übergabepunkt TTG/AMP – Wehrendorf	Line	-
P40	M26	Graustein – Bärwalde	Line	-
P47a	M64	Kriftel – Farbwerke Höchst-Süd	Line	-
P48	M38b	Punkt Rittershausen – Stalldorf – Kupferzell	Line	-
P50	M556	Hoheneck – Pulverdingen	Line	-
P51	M37	Großgartach – Endersbach	Line	-
P53	M431	Irsching – Sittling	Line	-
P74	M96	Vöhringen – Punkt Bundesgrenze (AT)	Line	-
P74	M97	Woringen/Lachen	Line	-
P84	M367	Hamburg/Nord – Hamburg/Ost	Line	-
P84	M368	Hamburg/Ost – Krümmel	Line	-
P113	M202a	Krümmel – Lüneburg – Stadorf	Line	-
P113	M202b	Krümmel – Lüneburg – Stadorf	Line	-
P113	M203	Stadorf – Wahle	Line	-
P113	M204	Stadorf – Wahle	Line	-
P116	M206	Sottrum – Landesbergen	Line	-
P124	M209b	Klostermansfeld – Querfurt	Line	-
P127	M397	Röhrsdorf	Plant	-
P132	M252	Lippe – Mengede	Line	-

Table 6: List of non-confirmed measures

Project	Measure	Grid connection points	Type	Project according to BBPlG 2015
P135	M255	Bechterdissen – Ovenstädt	Line	-
P152	M354	Wahle – Klein Ilsede	Line	-
P152	M370a	Klein Ilsede – Mehrum	Line	-
P153	M355	Alfstedt	Plant	-
P159	M62	Bürstadt – BASF	Line	-
P171	M381	Hanekenfähr – Merzen	Line	-
P202	M428	Hattingen – Wanne	Line	-
P203	M429	Amelsbüren/Waldstedde	Line	-
P205	M416	Eichstetten/Kühmoos	Line	-
P225	M464a	Altheim – Isar	Line	-
P227	M468	Lübeck – Krümmel	Line	-
P228	M469	Landesbergen – Wahle	Line	-
P232	M477	Karben – Großkrotzenburg	Line	-
P235	M493	Lastflusssteuernde Maßnahme Cloppenburg	Plant	-
P236	M472	Würgassen – Bergshausen	Line	-
P236	M473	Bergshausen – Borken	Line	-
P251	M501	Pulgar – Lauchstädt	Line	-
P252	M504	Thyrow – Berlin/Südost	Line	-
P300	M492	Grafenrheinfeld – Rittershausen	Line	-
P302	M511	Höpfingen – Hüffenhardt	Line	-
P302	M551	Höpfingen – Hüffenhardt	Line	-
P303	M513	Großgartach – Hüffenhardt	Line	-
P304	M514	Kupferzell – Goldshöfe	Line	-
P305	M515	Niederstotzingen – Dellmensingen	Line	-
P305	M517	Rotensohl – Niederstotzingen	Line	-

Table 6: List of non-confirmed measures

Project	Measure	Grid connection points	Type	Project according to BBPlG 2015
P306	M557	Großgartach – Hoheneck	Line	-
P307	M482	Bürstadt – Pfungstadt – Bischofsheim – Urberach	Line	-
P308	M483	Kriftel – Bürstadt	Line	-
P309	M484	Bürstadt – Rheinau – Hoheneck	Line	-
P311	M486	Weißenthurm – Bürstadt	Line	-
P312	M487	Westerkappeln – Wettringen	Line	-
P316	M474	Karben – Kriftel	Line	-
P317	M494a	Eiberg – Bochum	Line	-
P317	M494b	Bochum – Hattingen	Line	-
P318	M495	Rommerskirchen – Paffendorf	Line	-
P320	M497	Oberzier – Dahlem	Line	-
P323	M509	Lastflusssteuernde Maßnahme in Hessen	Plant	-
P324	M512	Witten – Hattingen	Line	-
P330	M550	Rittershausen – Höpfingen	Line	-
P331	M552	Großgartach – Kupferzell	Line	-
P332	M510	Rittershausen – Höpfingen	Line	-

Note

A large number of the measures not confirmed in the NDP 2017-2030 are unlikely to contribute significantly under the Bundesnetzagentur's methods of testing to reducing the congestion and overload expected for the year under consideration 2030. The assessment of these measures could, however, change in later network development plans under possibly different framework conditions, in particular as the energy transition progresses. The TSOs can again propose, in following proceedings, measures not confirmed in current proceedings.

4. Examination of ad hoc measures

The purpose of the Network Development Plan 2017-2030 is to identify the long term grid expansion requirements for the target year 2030. But it can also help to meet short term challenges arising from the energy transition. As expansion of the grid, in particular construction of the long distance HVDC lines, will not be completed before the exit from nuclear power in 2022, additional resource input will be required for congestion management and redispatch from 2022 until the HVDC lines are put into service.

To compensate for the ensuing costs and to safeguard system security it may prove worthwhile to implement expansion measures that, admittedly, will not be of great importance in the target year 2030 but which, in the intervening period from 2022, will deliver more benefit than they actually cost. That said, the only eligible expansion measures are those whose planning and construction is straightforward, which, for their part, will not have any significant environmental effects and which will not cause any major conflict for spatial planning. Otherwise, realisation by 2022 would be an illusion. Measures such as these are designated ad hoc measures.

As ad hoc measures serve to lower congestion costs during a transition period they must appear in every way capable of implementation in the short term so that significant benefits can be expected until such time as the projects in the federal requirements plan come on stream. To this end, each measure is analysed in terms of the expected timescale needed for its approval and implementation. If, accordingly, an ad hoc measure appears capable of implementation in the short term, the Bundesnetzagentur studies its suitability for meeting energy supply requirements with reference to an additional scenario for the "intervening" year 2023. This provides a linear breakdown of the assumptions made in Scenario B 2030 on, for instance, the development of renewables, consumption load and the development of fuel costs, back to the year 2023. The expansion of the grid that is assumed realised by 2023 is derived from the data given in the Federal Requirements Plan Monitoring (status: 1st quarter 2017).

The criteria of necessity and effectiveness are not appropriate for ad hoc measures, which is why these measures are looked at with reference to an economic analysis: the benefit that an ad hoc measure delivers over a specified period must outweigh its costs. The benefit of an ad hoc measure lies in the avoidance of costs that would otherwise be incurred for redispatch and feed-in management, in other words for constraining off renewable energies plant and for firing up conventional power stations.

It is true that the avoidance of feed-in management does not have any directly quantifiable monetary effect in purely national economic terms since the feed-in tariffs saved are roughly the same as the compensation payments to the generating plant operators. However, the less such feed-in management is required, the more renewable generation will take the place of conventional generation and the more CO2 emissions in power production will fall. The avoidance of feed-in management is thus absolutely necessary if the objectives of the energy transition are to be achieved. Accordingly, the electricity from renewables that is constrained off as a result of feed-in management must be assigned a value.

The Bundesnetzagentur, with reference to the compensation rates paid for feed-in management (source: Monitoring Report 2016) has therefore decided to assess avoided feed-in management in monetary terms at 100 euros per megawatt-hour (MWh). Total monetary benefit is calculated for the intermediate scenario and must be multiplied by the number of years in which the measure unfolds its effect. Essentially, this period stretches from the realistic implementation of the ad hoc measure up to the planned coming on stream of important projects in the federal requirements plan which, for their part, have an influence on the effectiveness of the ad hoc measure. For the economic analysis three years are set for this period.

In their revised draft Network Development Plan 2017-2030 the transmission system operators proposed five ad hoc measures for the first time. During the consultation a further six in the form of phase shifting transformers were added. Further, the Bundesnetzagentur has added to its study Projects P323 and P327 as possible ad hoc measures, as these are likewise phase shifters that can be realised within a short space of time.

The possibility that ad hoc measures will influence each other due to their electrical proximity needs to be taken into account in the technical testing. Thus the Bundesnetzagentur has decided on a sequential approach for its study of these measures, too. This will prevent a situation in which two or more measures are identified, each of which will in itself resolve the same problem in the network but which together will not deliver any significantly higher overall benefit.

The first step is a separate economic analysis for each measure so as to identify those measures with the greatest economic benefit. Subsequently the measures are looked at to see if they are far enough apart so that mutual influence can be ruled out to the greatest possible extent. If this is the case, the network is augmented by these

measures and a reassessment of the remaining ones made. In this way the network is augmented step by step until no economically feasible measures more are identified. Each step adds a maximum of three measures..

The Bundesnetzagentur considers nine of the thirteen ad hoc measures examined to be eligible for confirmation. Together, these nine measures account for as much as 96 percent of the total monetary benefit of all the ad hoc measures studied, yet require only 68 percent of the costs of all these measures.

To summarise, these nine measures will deliver a national economic gain of around two billion euros in the years 2023 to 2025. Positive benefit can also be assumed after this period has ended, since the continued operation of these measures will be to the good of the network.

Table 7: Confirmed ad hoc measures in the NDP 2017-2030

Project	Measure	Grid connection points	Type	Project according to BBPlG 2015
P113	M519	Stadorf/Wahle	Plants	-
P310	M485	Bürstadt – Kühmoos	Line	-
P327	M522	Lastflusssteuernde Maßnahme im Ruhrgebiet	Plant	-
P345	M556	Lastflusssteuernde Maßnahme in Hamburg/Ost	Plant	-
P346	M557	Lastflusssteuernde Maßnahme in Hanekenfähr	Plant	-
P347	M558	Lastflusssteuernde Maßnahme in Oberzier	Plant	
P348	M559	Lastflusssteuernde Maßnahme in Wilster	Plant	
P349	M560	Lastflusssteuernde Maßnahme in Würgau	Plant	
P350	M561	Lastflusssteuernde Maßnahme in Pulverdingen	Plant	

Tabelle 8: Non-confirmed ad hoc measures in the NDP 2017-2030

Project	Measure	Measure	Type	Project according to BBPlG 2015
P50	M556	Hoheneck – Pulverdingen	Line	-
P309	M484	Bürstadt – Rheinau – Hoheneck	Line	-
P323	M 509	Lastflusssteuernde Maßnahme in Urberach	Plant	-
P324	M512	Witten – Hattingen	Line	-

Non-confirmed ad hoc measures likewise reduce congestion. However, as ad hoc measures are subject to mutual influence, total potential is reduced in relation to an individual assessment.

Moreover, phase shifting transformers cost less than the ad hoc route measures originally submitted and therefore deliver a considerably better outcome in a cost-benefit analysis..

Figure 1: Confirmed measures

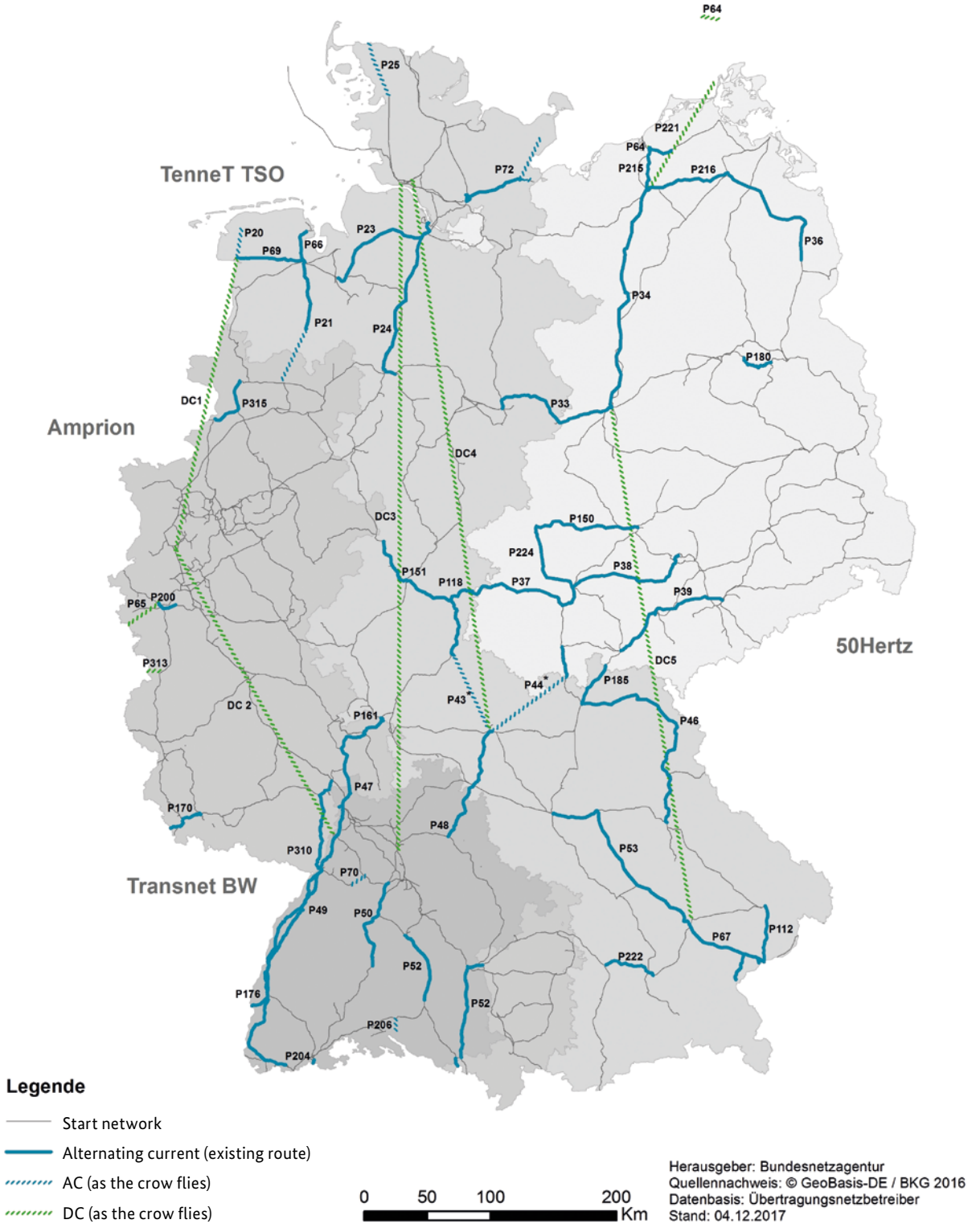


Figure 2: Non-confirmed measures

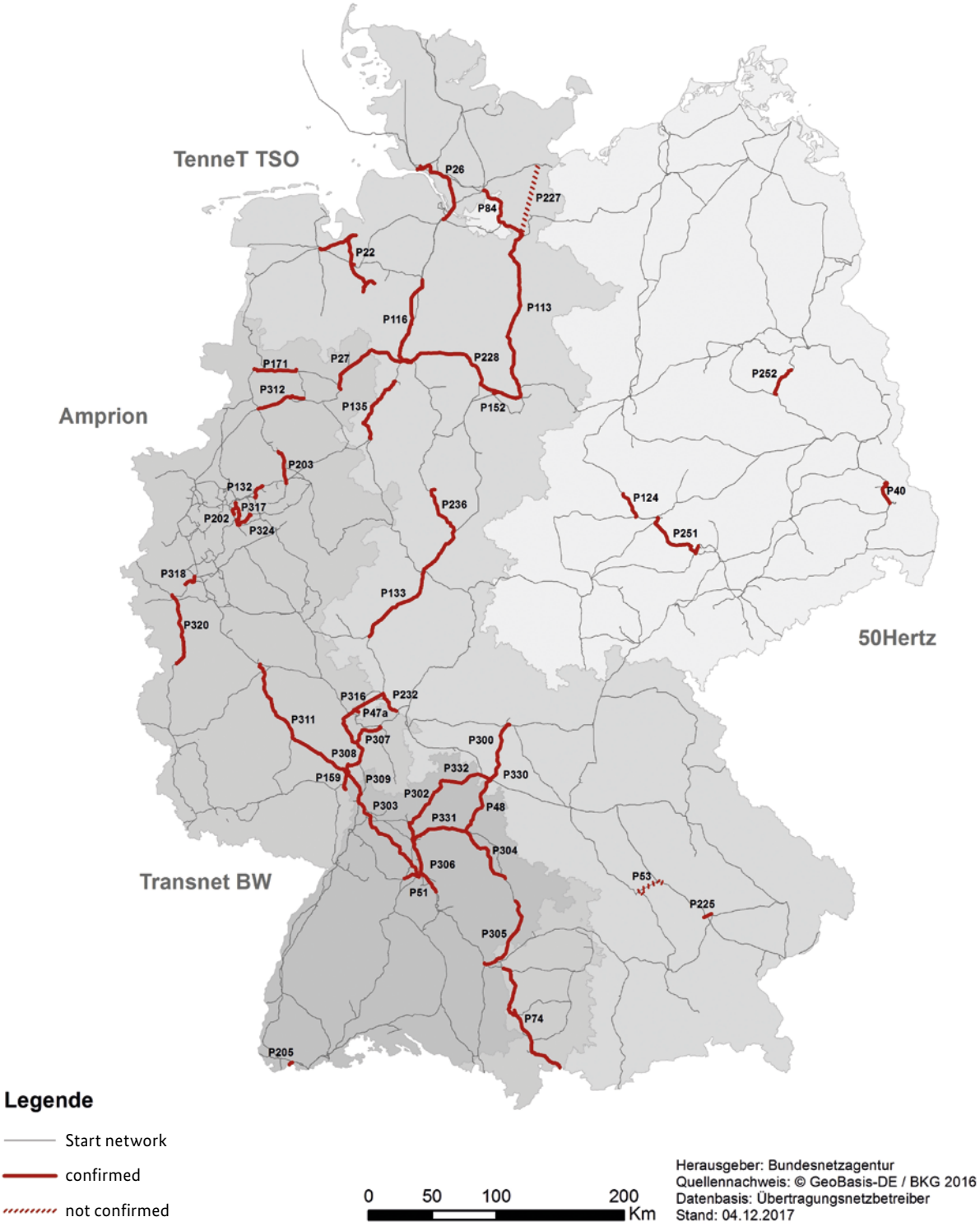


Figure 3: Measures augmenting the federal requirements plan

Figure 4: Ad hoc measures

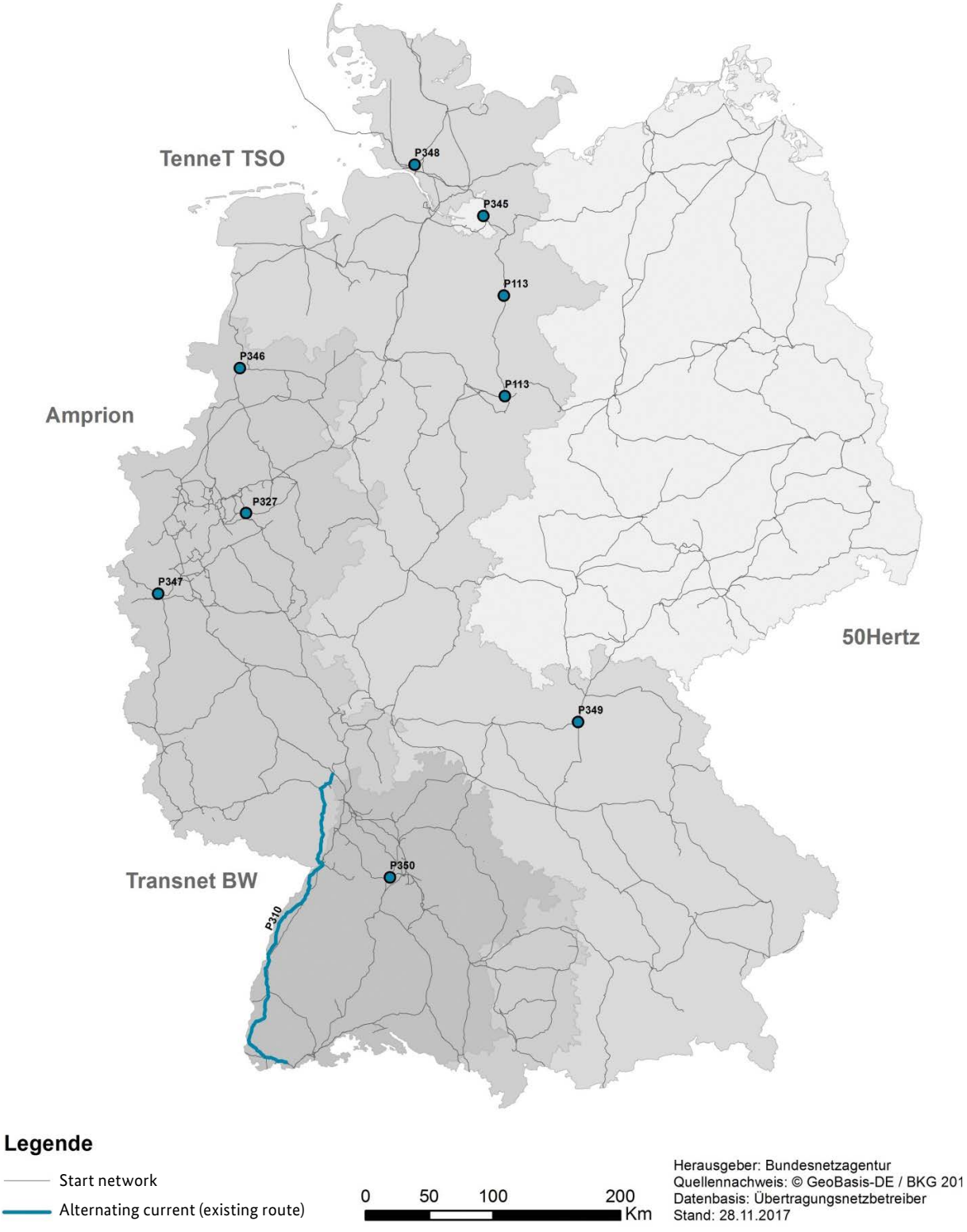
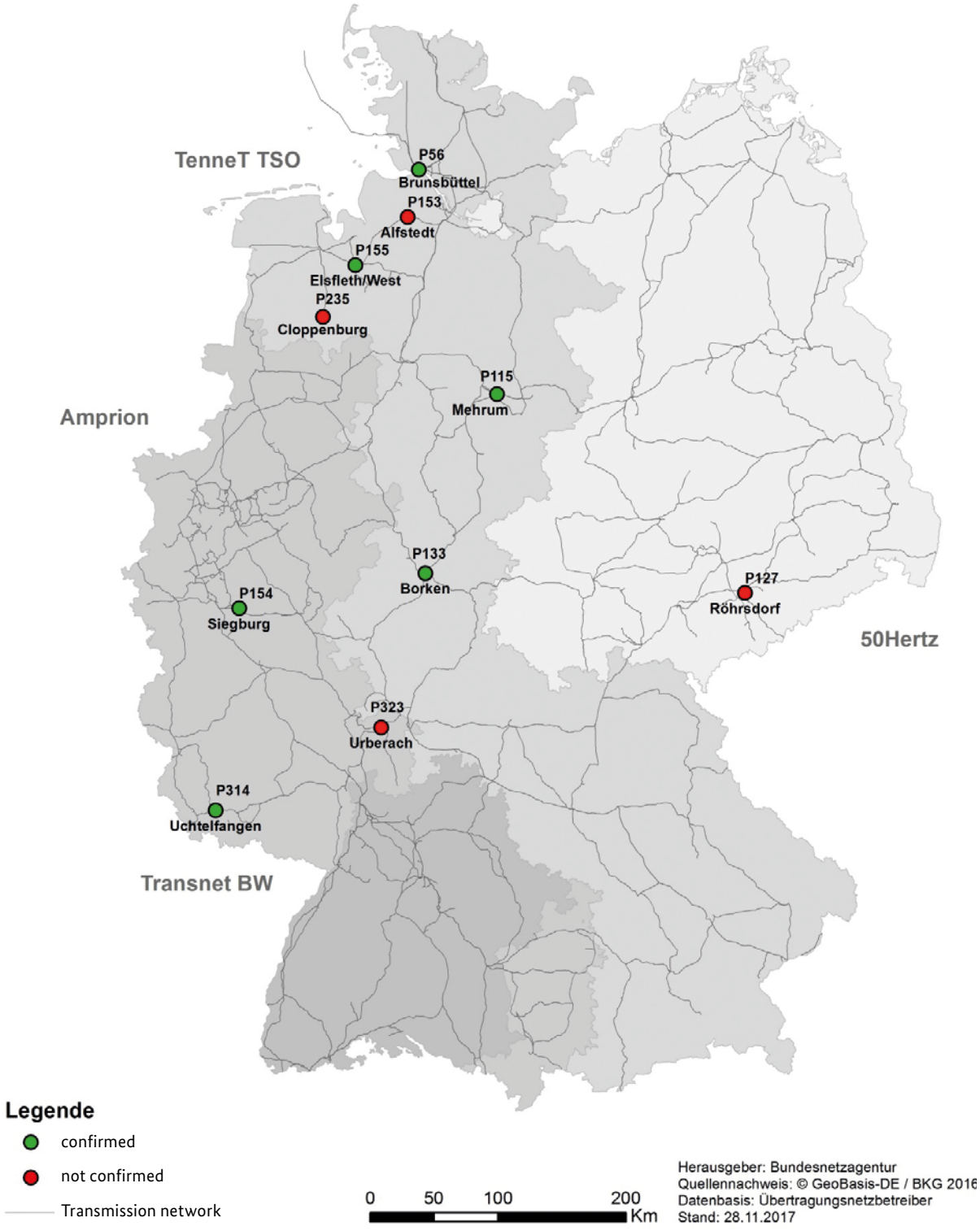


Figure 5: Network point measures



C Confirmation of the Offshore Network Development Plan 2017-2030

1. Methodology

The O-NDP identifies the requirements for the construction of new systems to connect so-called "clusters". A cluster comprises a number of adjacent offshore wind farms that form a self-contained area, as it were, allowing them to be linked via one hub connection. It is incumbent on the Bundesnetzagentur to ensure, in conjunction with the Federal Maritime and Hydrographic Agency (BSH), that the O-NDP is in compliance with the requirements of the Energy Act (EnWG).

However, the introduction of an auction system for the generation of electricity from renewables is bringing about a "system change" for offshore wind energy too. The main arrangements for offshore wind energy are set out in the Offshore Wind Energy Act (WindSeeG). Under the Act, for offshore wind farms commencing operation in 2026 and beyond, auctions will be held for sites in the North and Baltic Seas that have undergone a preliminary governmental study. For offshore wind farms coming on stream between 2021 and 2025 a transitional system has been put in place in which existing projects can take part in two auctions. The confirmed O-NDP provides the basis for the two auctions in the transitional system in respect of the connecting systems.

Meanwhile, the first of the two auctions has been held on the basis of the confirmed O-NDP 2025. The requirements for offshore connections will be established in the so-called target model in future by the onshore NDP on which, in turn, the determinations of the Land and Sites Development Plan (FEP) are to be based. Thus the O-NDP 2017-2030 will be the last O-NDP.

The individual stages underlying examination of the O-NDP are outlined in the following.

2. Examination

The O-NDP sets out the planning for connecting clusters in the whole of Germany's North and Baltic Sea areas. Unlike the NDP whose aim is expansion of the onshore electricity network for a secure and reliable supply of power, the O-NDP presents a plan for hub connections to enable clusters to be opened up. That is why examination of the O-NDP differs from that of the NDP.

Key to examining the onshore NDP is investigating the effectiveness of a measure. This involves looking at whether network security would also be given without the measure and whether reliable operation could continue. This situation is known as the n-1 criterion. By contrast, the failure of an offshore connecting system initially leads only to the particular offshore wind farm no longer being able to feed into the grid. As long as this lack of feed-in can be compensated for by feed-in from other sources the stability of the grid will not be affected in any way.

As, in accordance with the Energy Act, the requirements for offshore connections will be established in the so-called target model as from 2026 by the onshore NDP on which, in turn, the determinations of the Land and Sites Development Plan (FEP) will be based, confirmation of the connecting systems with a scheduled completion date after 2025 that are likely to be needed will be subject to confirmation of necessity by the confirmed NDP 2019-2030 on the basis of the determinations of the Land and Sites Development Plan.

The O-NDP is examined with reference to the criteria below:

Examination of the connecting systems

1. Consideration of the scenario framework
2. Consideration of the offshore federal sectoral plans
3. Expansion requirements
4. Criteria for the order of implementation
   a) distance from the shore of priority and suitable sites
   b) generating potential
   c) planned start of operation for the grid connection points
   d) realisation progress of the OWFs for connection
5. Statement of time periods
   a) binding date for the beginning of implementation
   b) planned completion date
6. Staggering the connection measures

The individual assessment criteria are described in the following.

2.1 Consideration of the scenario framework

The transmission system operators have taken the figures for generating capacity from offshore wind energy in accordance with the approved Scenario Framework 2017-2030. Accordingly, for the scenarios on which the examination is based the transmission system operators have divided up the whole of the capacity generated from offshore wind energy as follows: 11,700 megawatt (MW) in the North Sea and 3,300 megawatt in the Baltic.

2.2 Consideration of the offshore federal sectoral plans

The O-NDP 2017-2030 was drawn up on the basis of the determinations of the Federal Sectoral Plan for the North Sea (BFO-N) and those of the Federal Sectoral Plan for the Baltic Sea (BFO-O). This applies particularly as regards the cluster arrangement within the Exclusive Economic Zone (EEZ) undertaken in the offshore federal sectoral plan, identifying the clusters' generating potential and standardising the transmission technology.

In the Baltic Sea, the second draft of the O-NDP includes, in addition to the sites in the EEZ, sites in its territorial waters in accordance with the development programme for the federal state of Mecklenburg-Western Pomerania. Yet merging these sites with existing clusters in the EEZ in the Baltic would not be appropriate, the Bundesnetzagentur believes, since they are not directly adjacent and not therefore suitable for hub connections. The Bundesnetzagentur has therefore defined two additional clusters (Clusters 6 and 7) for the sites under consideration in the territorial waters of the Baltic Sea.

In the North Sea, standard connection to the grid under the specifications of the Offshore Federal Sectoral Plan for the North Sea is DC technology with a transmission capacity of 900 MW. In the Baltic, the standard connection under the specifications of the Offshore Federal Sectoral Plan for the Baltic Sea is AC technology with a transmission capacity of 250 MW. Exceptionally, DC technology could be considered as an alternative to multiple AC systems to open up any undeveloped potential in the Baltic after 2025.

2.3 Expansion requirements

The expansion requirements for the O-NDP 2017-2030 are derived with reference to the difference between the forecast offshore generating capacity for 2030 and the transmission capacity already covered by the start network, and the connections confirmed in the O-NDP 2025. The measures confirmed in the O-NDP 2025 will undergo re-examination only after the second auction in the transitional system on 1 April 2018 – then however with the expanded onshore NDP based on the Land and Sites Development Plan – provided wind farms are not awarded capacity on the relevant connection in one of the two auctions. If this should happen, the connection will then become part of the start network. This concerns the connecting systems NOR-1-1 (DolWin 5), NOR-3-3 (DolWin 6) and NOR-7-1 (BorWin 5). On NOR-7-1 (BorWin 5) wind farms were awarded capacity in the first auction on 1 April 2017. Hence the other connections confirmed in the O-NDP 2025 do not need re-examination before conclusion of the second auction. Re-examination under the O-NDP 2017-2030 could not deliver a different outcome, in the Bundesnetzagentur's current thinking, where the connections to be confirmed until 2025 are concerned, as far as these connections qualify for the second auction on 1 April 2018. This applies at present to the connecting systems NOR-5-2 (SylWin 2), OST-2-1, OST-2-2 and OST-2-3. These target network connections confirmed in the O-NDP 2025 are designated in the following as the "target network 2025".

In light of the identification and regionalisation of offshore generation in the Scenario Framework 2017-2030, wind farms are to be opened up in 2030 with a capacity of approximately 11,700 MW in the North Sea and approximately 3,300 MW in the Baltic Sea. Disregarded in the target requirements is the capacity of wind farms already opened up by the start network or by the connections (start network and target network 2025) confirmed in the O-NDP 2025.

If the point of orientation in this is the transmission capacity of the connecting systems, the capacity of the offshore wind farms considered in the start network and the target network 2025 covers up to 10,700 MW in the North Sea and around 1,800 MW in the Baltic. Should the transmission capacity of the start network be greater than the generating potential of the particular cluster, the generating potential of the particular cluster should however – instead of the transmission capacity of the start network – be subtracted from the forecast offshore generating capacity.

The relevant information in the Offshore Federal Sectoral Plan for the North Sea and the Offshore Federal Sectoral Plan for the Baltic Sea is consulted for the generating potential of the clusters. Consequently, the target network requirements for the North Sea are to be reduced by around 10,400 MW (start network without non-usable transmission capacity).

This still leaves target network requirements of approximately 1,300 MW for the period 2026 to 2030. In no cluster in the Baltic is the generating potential exceeded

by the transmission capacity of the lines in the start network, so that for the period 2026 to 2030 the target network requirements remain at around 1,500 MW.

How many connecting systems these expansion requirements will be spread amongst will also depend on the transmission capacity of the individual maritime cables. Given a transmission capacity of 900 MW per connection in the North Sea and between 750 and 1,000 MW per connection in the Baltic Sea, two connecting systems in the North Sea and two in the Baltic will be needed for the period 2026 to 2030 in addition to the total of four connecting systems provided for by the target network 2025. A DC connecting system comprises a cable with 900 MW transmission capacity, an AC connecting system, depending on the total capacity planned, comprises multiple cables each with 250 MW capacity.

2.4 Criteria for the order of implementation

Based on the criteria proposed in the Energy Act the TSOs, in their examination, have employed the criteria below, in the following order, so as to establish how the offshore grid expansion measures should be staggered:

1) distance from the shore,

2) respective generating potential of an offshore wind energy cluster,

3) planned start of service of grid connection points, and

4) realisation progress of the offshore wind farms for connection.

The application of the criteria and the order in which they appear in the second draft of the O-NDP is appropriate, in the Bundesnetzagentur's view.

The Bundesnetzagentur currently considers the criterion "Distance from the shore" as presented by the TSOs appropriate. The TSOs have divided the North Sea into five zones, as opposed to the single zone they provide for in the Baltic. Accordingly, all the clusters in the Baltic are treated equally in respect of their distance from the shore.

Likewise, the Bundesnetzagentur views application of the criterion "Generating potential of an offshore wind energy cluster" as appropriate.

The criterion "Planned start of operation for the grid connection points" as a corrective criterion also appears to the Bundesnetzagentur to have been applied appropriately.

The Bundesnetzagentur regards consideration of the criterion "Progress of realisation of the offshore wind farms for connection" appropriate as a corrective so as to avoid a highly unsuitable outcome for offshore connections planned for completion up to and including the year 2025. However, this criterion will no longer be applicable with regard to government site planning after 2025.

2.5 Statement of time periods

In their second draft of the O-NDP 2017-2030 the TSOs have given the year of commissioning, that is of awarding the contract for the connector, as the beginning of implementation. This is appropriate in the Bundesnetzagentur's view. The O-NDP must also state the planned date of completion for the connection measures. The O-NDP is in compliance.

The second draft of the O-NDP generally envisages 5 years as the period from the beginning of implementation until completion of the connecting systems for the North and the Baltic Seas. In the Baltic this applies to AC connecting systems consisting of a minimum of three AC maritime cables. Here, the TSOs are working on the assumption of a 60-month period for realisation of the connecting systems. These time periods are permitted for this year's O-NDP.

2.6 Staggering the connection measures

2.6.1 Staggering the connection measures for the North Sea

The Bundesnetzagentur has confirmed the three necessary connecting systems in the North Sea in the following order:
(1) NOR-5-2, (2) NOR-3-2, (3) NOR-7-2.

The connecting system NOR-5-2 is to be realised in 2025 in accordance with confirmation of the O-NDP 2025. Hence as the first system it also has to be confirmed in the O-NDP 2017-2030.

As regards the two connecting systems required between 2026 and 2030, a selection according to the distance from the shore in zones must be made in a first step. The following clusters are located in Zone 1: Cluster 0 (North Sea territorial sea), Cluster 1, Cluster 2, Cluster 3, Cluster 4 and Cluster 5 in part. Cluster 0, Cluster 1, Cluster 2, Cluster 4 and that part of Cluster 5 that is located in Zone 1 are fully covered by the connecting systems in the start network. Hence only Cluster 3 requires consideration within Zone 1. Since Cluster 3, as the only cluster still to be developed, still has potential, the second connecting system to be confirmed is routed to Cluster 3 (NOR-3-2), which would then be fully opened up.

In line with the criterion "Distance from the shore", Zone 2 would be developed next. Located in Zone 2 are Clusters 6, 7 and 8 and part of Cluster 5. Cluster 5 would already be fully opened up by the NOR-5-2 connection included in the target network 2025 and hence requiring renewed confirmation. As the remaining undeveloped potential in Cluster 7 is greater than that in Clusters 6 and 8, Cluster 7 would be opened up first via the NOR-7-2 connecting system, whereas the system NOR-6-3 applied for in the second O-NDP 2017-2030 draft – due to a lack of requirements for a further connecting system until 2030 – would only be realised after 2030. However, an appropriate alternative would be to develop the remaining potential of both clusters via a connection which, designed as a general connection, would also include Cluster 6.

Still lacking after the measures have been staggered according to the criteria "Distance from the shore" and "Generating potential" is the plausibility of the staggering with reference to the criterion "Planned completion date for grid connection points". Grid connection points will be available in principle for all the connecting systems by the scheduled completion date.

After 2025 there will be no more plausibility checks of the staggering, as described above, of the connecting systems with reference to the criterion "Realisation progress of the offshore wind farms for connection"..

2.6.2 Staggering the connection measures for the Baltic Sea

The Bundesnetzagentur has confirmed the three necessary connecting systems in the Baltic Sea in the following order:

(1) OST-2-1, (2) OST-2-2, (3) OST-2-3, (4) OST-2-4, (5) OST-6-1.

The connecting systems OST-2-1, OST-2-2 and OST-2-3 are to be realised in 2021 and 2022, in line with the confirmed O-NDP 2025. Hence these, as the first systems, are to be confirmed in the O-NDP 2017-2030 also.

Since all the clusters in the Baltic Sea are placed in the same zone, no preselection is made using the distance criterion. Determining the order in which the two further connecting systems needed after 2025 will be installed is therefore the generating potential that is still to be tapped and which, as in the North Sea, is obtained from the difference between the generating potential per cluster according to the Federal Sectoral Plan for the North Sea and the transmission capacity of the start network and the target network 2025 according to the data in the second O-NDP 2017-2030 draft.

It makes sense in the target model as well to open up Clusters 1, 2 and 4 as per the confirmed O-NDP 2025 via hub connections that can link sites from all three clusters. If, on the one hand, realisation of the three connections to Clusters 1, 2 and 4 is assumed for 2021 and 2022 and if, on the other, Clusters 3 and 6 are regarded separately, the undeveloped potential of Clusters 1, 2 and 4 – unlike how the second O-NDP 2017-2030 draft provides for – is greater than the potential of the remaining clusters that is still to be developed.

That is why the first connection in the Baltic runs to Clusters 1, 2 and 4 (OST-2-4). Clusters 1, 2 and 4 are then deemed developed. Cluster 6 in the territorial sea then shows the greatest untapped generating potential; consequently the second connection in the Baltic runs to Cluster 6 (OST-6-1). Connecting system OST-6-1 corresponds to the connecting system designated in the second O-NDP 2017-2030 draft as OST-3-3. Cluster 6 is then regarded as developed. The remaining clusters have considerably less generating potential as matters stand at present and will therefore be required only after 2030.

Grid connection points will be available in principle for all the connecting systems at the scheduled time of completion, according to the plans of the transmission system operators in their NDP 2017-2030. Plausibility checks of the staggering of the connecting systems with reference to the criterion "Realisation progress of the offshore wind farms for connection" will no longer be made for the connecting systems after 2025.

2.6.3 Time periods for the connecting systems in the North and Baltic Seas

The application and completion dates for the connecting systems OST-2-1, OST-2-2, OST-2-3 and NOR-5-2 confirmed in the O-NDP 2025 will not undergo fresh examination in the O-NDP 2017-2030. The other connecting systems needed, two in the North Sea and two in the Baltic, are to be evenly spaced timewise.

As matters stand at present, no further connecting systems are required in the North or Baltic Seas in 2026. Initially, any available capacities in the start network and the target network 2025 are to be used in the target model primarily by predeveloping the sites of the particular clusters with priority and opening them up using connections that have already been confirmed.

Since, under this assumption, sites in the North Sea would be predeveloped in 2026, the next connecting system would be realised in the Baltic in 2027 (OST-2-4), then in the North Sea in 2028 (NOR-3-2), in the Baltic in 2029 (OST-6-1) and in the North Sea again in 2030 (NOR-6-3).

As the time taken to realise the connecting systems is currently put at 60 months from the time of application, OST-2-4 must be applied for in 2022, NOR-3-2 in 2023, OST-6-1 in 2024 and NOR-7-2 in 2025.

3. Findings

Both confirmed and non-confirmed connecting systems in the O-NDP 2017-2030 are shown in Figure 1 for the North Sea and in Figure 2 for the Baltic Sea.

Figure 1: Confirmed connecting systems in the North Sea

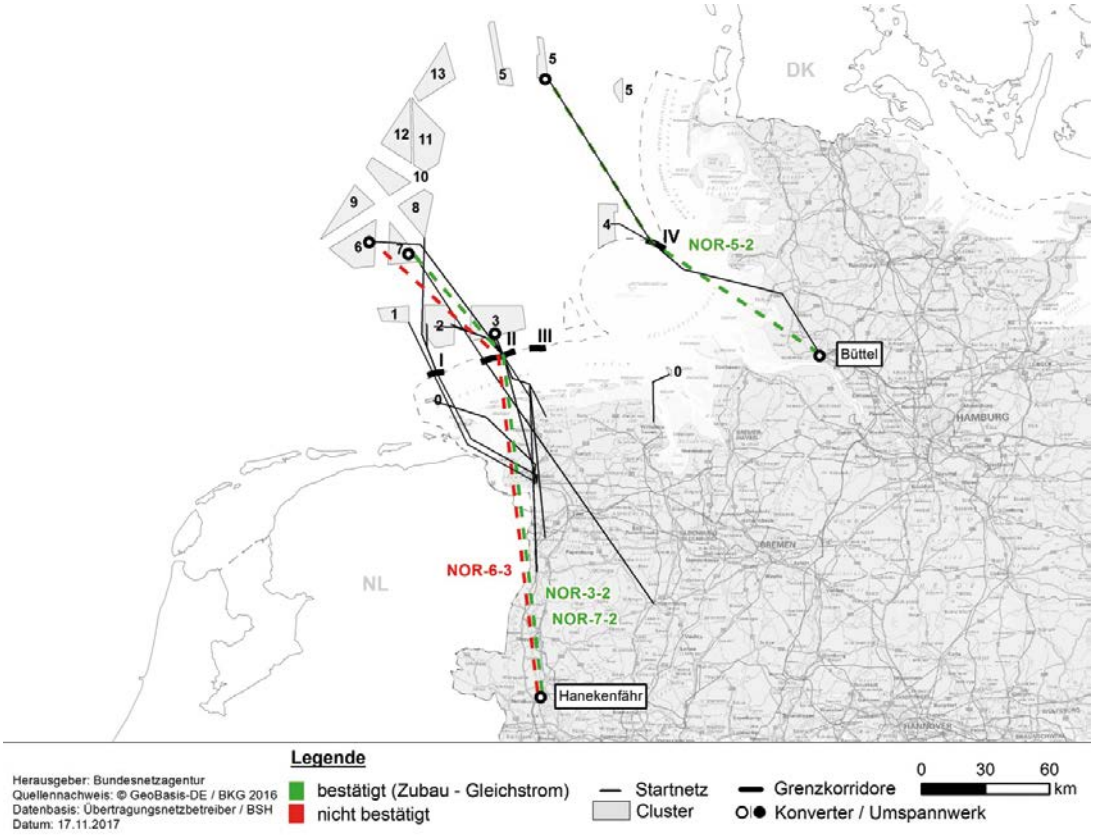


Figure 2: Confirmed connecting systems in the Baltic Sea

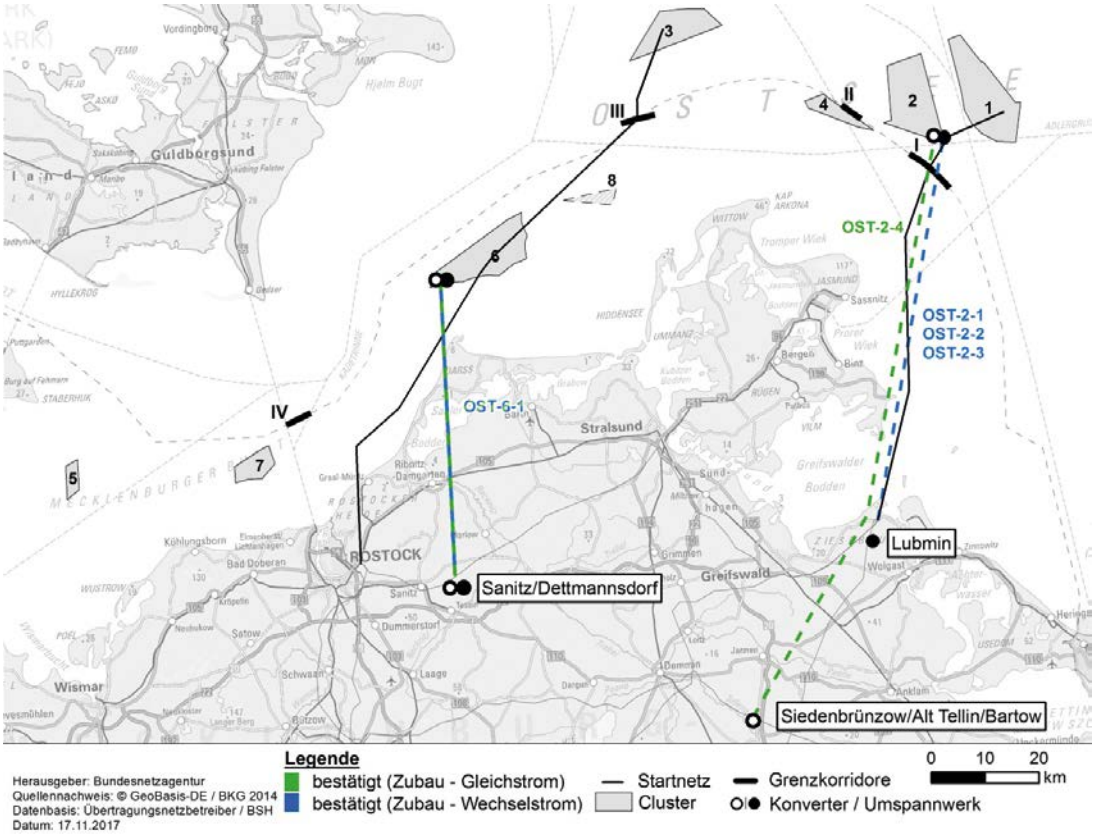


Table 1: Confirmed connection measures

Connecting system	Start of implementation	Planned completion	Cluster connection to grid
NOR-5-2 (SylWin 2)	2020	2025	5 (North Sea)
NOR-3-2 (DolWin 4)	2023	2028	3 (North Sea)
NOR-7-2 (BorWin xxxx)	2025	2030	6 und 7 (North Sea)
OST-2-1	2018	2021	1,2 und 4 (Baltic Sea)
OST-2-2	2018	2021	1,2 und 4 (Baltic Sea)
OST-2-3	2018	2022	1,2 und 4 (Baltic Sea)
OST-2-4	2022	2027	1,2 und 4 (Baltic Sea)
OST-6-1*	2024	2029	6 (Baltic Sea)

*Designated OST-3-3 in the second O-NDP 2017-2030 draft.
Connecting system NOR-6-3 will not be confirmed.

D On the environmental report Strategic Environmental Assessment based on the second draft of the Electricity NDP 2017-2030 and the O-NDP 2017-2030

1. Procedure

1.1 Strategic environmental assessment

Environmental assessments are designed to ensure that possible effects on both the environment and the population are taken into account before and during the implementation of particular projects, plans and programmes. Grid expansion is no exception. A Strategic Environmental Assessment (SEA) kicks in at the planning level already, not later on when the projects are actually being implemented. It is at the preparatory stage of the federal requirements plan therefore that any possible effects caused by expanding the extra-high voltage transmission network are to be identified. The SEA thus serves as an early warning system.

1.2 Are there alternatives?

In an SEA, alternatives must be considered at the earliest possible stage if there is to be proper stewardship of the environment. Yet only the "reasonable" alternatives are explored. This means alternatives that are feasible and that can be identified without undue effort. Moreover, they must contribute to achieving, in essence, the aims of the underlying plan – that is to say in the case of grid expansion, the network development plans. Which alternatives ultimately find their way into the federal requirements plan also depends on other aspects: for instance, technical feasibility and economic efficiency. But the environmental assessment is not concerned with these. The legislature must weigh all the relevant aspects in adopting the federal requirements plan.

1.3 What is the environmental report?

The environmental report is the presentation, in text and graphics, of the possible environmental effects of grid expansion that have been identified and evaluated in the SEA. Looked at in the report were solely the potential significant, or adverse, environmental effects on the so-called protected assets. These protected assets are named in the Environmental Impact Assessment Act (UVPG) as follows:

- Humans and human health[1]
- Flora, fauna and biodiversity,
- Soil, water, air, climate and landscape,
- Cultural heritage and other material assets,
- Interaction between the above protected assets.

1.4 What is the draft environmental report based on?

In preparation for the federal requirements plan the Bundesnetzagentur carries out an SEA based on the network development plans. The SEA begins with a scoping exercise which lays down, amongst other things, the methodology and level of detail for the assessment. After input primarily from those public authorities whose environmental and health remit is affected by the network development plans, the scope was determined and published in April 2017. This is the basis on which the draft environmental report was drawn up and made the subject of a consultation running from 4 August 2017 to 16 October 2017 with the participation of specialists and the affected general public.

1.5 What has changed compared to the last environmental report?

Compared to the SEA on the Electricity NDP and the O-NDP 2024 the scope, as published, has undergone a slight modification. Following an amending law in December 2015 amendments were made, in addition to provisions of the Energy Act (EnWG), to the Federal Requirements Plan Act (BBPlG), the Power Grid Expansion Act (EnLAG) and the Grid Expansion Acceleration Act (NABEG). The Federal Requirements Plan Act now gives explicit priority to underground cabling for the extra-high voltage direct current transmission lines designated "E", so that these may only be set up as overhead lines in sections, under strict conditions. In and around residential areas installation as overhead lines is even prohibited at all times.

For the extra-high voltage alternating current transmission lines the criteria for the pilot projects that enable partial underground cabling have been widened and specific further projects included that are envisaged as pilot projects for partial underground cabling. A section of underground cable may now be laid not only on the edge of residential areas but also in cases in which an overhead line would violate certain nature conservation interests intended under the Federal Nature Conservation Act (BNatSchG) to protect species and areas – or when the line is to cross a major federal waterway. It was also clarified that partial underground cabling is also possible when the criteria cited

[1] Im Weiteren wird auch die verkürzte Bezeichnung 'Schutzgut Mensch' verwendet.

are not met along the entire length of the technically and economically efficient section. In order to gain experience of other technical solutions for undergrounding extra-high voltage lines the Federal Requirements Plan Act and the Power Grid Expansion Act stipulate that underground cable can also encompass earth cable such as cable tunnels and cable structures such as culverts or gas-insulated transmission lines (GILs). Such technical solutions could prove advantageous, or even necessary, should other underground cable engineering not come under consideration for technical or planning reasons

The amendments to the Grid Expansion Acceleration Act (NABEG) relate to the approval procedures following on from federal requirements planning, that is to say federal sectoral planning and planning approval. Accordingly, a particular focus now of the Bundesnetzagentur's study of the HVDC projects, under the Federal Requirements Plan Act to be implemented primarily as underground cable, is the extent to which the route corridor can run between the start and end points of the projects in as straight a line as possible. Federal sectoral planning gives considerable importance to the optimisation requirement of linearity, a requirement that developers must observe in determining suitable route corridors. The forecast of the environmental effects in the strategic environmental assessment pertaining to the federal requirements plan also assumes narrower assessment areas without thereby anticipating the definition of area under assessment in federal sectoral planning. As an overhead line can be considered solely by way of exception and under very strict conditions for direct current projects for which underground cables have priority, the projects, moreover, are assessed solely in relation to the impact on the environment caused by undergrounding.

Moreover, on 29 July 2017 the Environmental Impact Assessment Modernisation Act (Gesetz zur Modernisierung des Rechts der Umweltverträglichkeitsprüfung) came into force. The amendment of the law introduced some changes to the protected assets. Amongst other things, the protected asset "land" is included in the Environmental Impact Assessment Act (UVPG) for the first time, the protected asset "cultural and other material assets" is renamed "material assets and cultural heritage" and the protected asset "human being" refers "in particular" to human health. This SEA can be carried out on the basis of the legislation hitherto applicable, as the transitional periods make this possible.

On account of the Ivenack Oak Park being named Germany's first national nature monument in August 2016 this category of protected area was also included for the first time in the SEA considerations on overhead lines and underground cables. National nature monuments were viewed under the Federal Nature Conservation Act analogously to the national parks in relation to the protected assets of fauna, flora, biodiversity and landscape. The criterion was accorded high sensitivity each time.

The methodology used in previous years for the SEA has been largely retained. Aside from specific determinations on the study of alternatives, clarifications, above all, have been included – as a result of public participation on the scoping.

Compared to the last published environmental report the following basic changes and refinements can be noted:

- Changed area under assessment: narrower ellipse for HVDC projects marked with an "E" in the Federal Requirements Plan Act and for candidate projects for such marking and their alternatives. Moreover, these projects are now examined solely in respect of the environmental impact of underground cabling.

- Looked at in the study of alternatives are alternatives to individual measures and alternatives to overall plans. Scenarios A 2030 and C 2030 have been identified as reasonable overall plan alternatives. Further, Scenario B 2030 in the second NDP draft is regarded as an alternative overall plan. Fifty one alternatives to individual measures have been studied.

- Inclusion of national nature monuments as provided for by the Federal Nature Conservation Act in the SEA on overhead lines and underground cables.

1.6 What exactly has the Bundesnetzagentur examined for the environmental report?

The scenario framework approved by the Bundesnetzagentur for the NDP 2017-2030 and the O-NDP 2017-2030 sets out a conservative scenario (A 2030), a transformation scenario (B 2030) and an innovation scenario (C 2030).

The subject-matter of this year's SEA is as follows:

- Examination of 65 confirmed projects for the target network. These projects comprise 81 NDP measures and 11 O-NDP measures – one project can consist of several measures. The interconnector between Güstrow and southern Sweden was assigned to the O-NDP and the ad hoc measure was not included in the statistical analysis, so that this analysis relates to

79 confirmed NDP measures and 12 confirmed O-NDP measures.

Additionally, the following alternatives were studied:

- Scenarios A 2030, B 2030 and C 2030 as alternative overall plans
- 51 project-specific alternatives.

Not examined are so-called start network measures since these have either been implemented already or their necessity has already been determined by law. Nor are so-called network points measures such as substations looked at. Network points measures are not an integral part of the federal requirements plan and are not therefore the subject matter of the SEA and the environmental report. Offshore projects located in the Exclusive Economic Zone (EEZ) of the North and Baltic Seas undergo an SEA by the Federal Maritime and Hydrographic Agency (BSH) right at the time the offshore federal sectoral plan is drawn up.

2. On the methodology: How does the Bundesnetzagentur go about the environmental report?

Investigated in the SEA is where, and to what extent, potential environmental effects are likely and how far they are viewed as significant. The individual steps are outlined in the following.

2.1 Defining the area under assessment

Exactly where lines and routes will run is not determined at the level of the federal requirements plan. Decided is simply the grid connection pointsand the supports needed along the line. The Bundesnetzagentur has created ellipses around the grid connection points to facilitate defining the area for assessment. It would still be economically feasible to realise the routes within these ellipses, it believes. The ellipses – also called sub-areas under assessment in the following – enclose the grid connection points.

Figure 1: Schematic comparison of 2:1 ellipses (used for overhead lines) and HVDC ellipses with reference to notional projects of different lengths

The geometric construction of the ellipses distinguishes between two cases (see Figure 1). In the first case an ellipse is used – as previously – whose minor axis (horizontal axis) measures half of the main axis (perpendicular axis) (2:1 ellipse). This is used for alternating current projects and for direct current projects for which priority is not given by law to underground cabling (currently BBPlG Project 2, Ultranet).

In the second case an ellipse is used specifically for HVDC projects with prioritised underground cabling, whose form tapers (HVDC ellipse) as the distance between two grid connection points increases. Conversely, the ellipse broadens, the closer two connection points are to each other.

Figure 2 depicts the area under assessment (total sub-areas) for Scenario B 2030, consisting of 156 measu-

res. Large parts of the federal territory are seen to be assessed as a result of the chosen approach.

2.2 Identifying impact factors and actual state

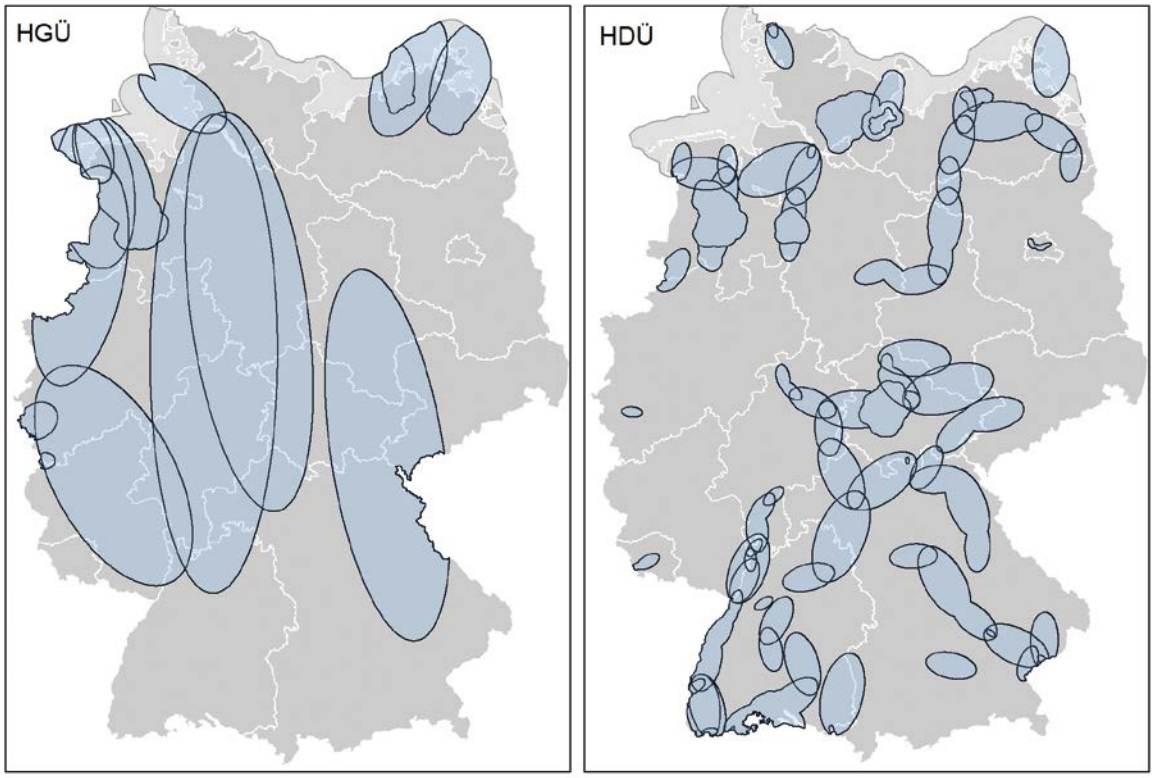
What effects grid expansion may be expected to have on individual protected assets depends on a number of factors. For instance, overhead lines have a different impact (impact factors) from underground or maritime cables.

Likewise, the environmental effects vary according to the choice of transmission method, direct or alternating current. That explains the distinction between HVDC (high-voltage direct current transmission) and HVAC (high-voltage alternating current transmission).

The first step describes the impact factors without a spatial reference. It depicts, for instance, the general impact of an overhead line on the protected asset landscape.

Additionally, the actual state of the environment is identified in the individual sub-areas under assessment. This is important as the significance of the effects can vary from region to region. Thus the frequency and distribution for instance of conservation areas differ markedly from each other in the regions in some cases.

Figure 2: Areas under assessment for confirmed HVDC and HVAC measures



2.3 Selecting relevant environmental objectives

The assessment in the environmental report is made with reference to previously defined (protection) objectives. At the present large-scale assessment level (scale 1:250,000) it is chiefly the European and national objectives as laid down, for instance, in the Federal Nature Conservation Act or the European Marine Strategy Framework Directive that are of importance.

2.4 Defining assessment criteria and stipulating assessment methods

Criteria relating to the protected assets are developed in order to achieve the protection objectives or assess how these will be affected by the impact factors, while not neglecting the level of the spatial survey. The criteria are derived from the environmental targets and the impact factors and assigned to one of the sensitivity categories "high", "medium", "not considered", or "not ascertainable". Existing protected areas, above all nature conservation areas or Natura 2000 sites, are used as criteria. Likewise shown as criteria are settlements, for instance.

The assessment is based on a worst-case scenario. This assumes significant effects caused by construction of the power line in order to guarantee maximum protection:

- In respect of the sensitivity of the criteria a blanket worst-case assumption is made.

- Due to the scale 1:250,000 smaller distances cannot be recognised. This leads, in part, to negative effects being assumed that are not actually present.

- The scale of this SEA rules out the inclusion of any prevention, mitigation or compensation measures..

- Possibilities for bundling with other linear structures are included for information purposes. However, every measure is regarded and assessed as a new-construction project.

This assessment may be qualified, however, at subsequent planning levels if more detailed information indicates that the sensitivity of the specific project and the specific area calls for a different assessment.

The assessment itself has two stages. Initially, in relation to the particular protected asset it is established whether there is a "bar" in the sub-area of highly sensitive sites. Such bars are constituted by one or more ecologically sensitive areas that cannot be skirted and that the line can cross only with difficulty or not at all without being likely to significantly affect the environment. This assessment is depicted by the following abbreviations (cf Table 1):

The second step shows the extent to which significant environmental effects are likely in the remaining part of the ellipse (cf Table 2).

2.5 Evaluating the fact sheets (survey of measures)

The measures featuring in the NDP and the O-NDP are examined in the form of fact sheets using the methodology set out above. All the protected assets are examined; first of all individually, then altogether.

The outcome is an A, A #, A ##, a B, B #, B ## or a C, C #, C ##assessment. A Natura 2000 assessment is also made for each sub-area, in other words an assessment of whether Natura 2000 sites could potentially be affected as a result of construction of the line.[2]

2.6 Surveying the overall plan

Looked at after the individual measures, projects and connection lines are the likely significant environmental effects resulting from the plan as a whole (Survey of the overall plan, cf Figure 3). This also includes studying aspects that cannot be described, or only with difficulty, in terms of land-specific criteria, (eg implications for climate change). The Natura 2000 assessment, also made for the overall plan, shows possible adverse effects for the grid, which would have to be investigated at the following planning levels.

Table 1: Depiction of the bars

Symbol	Meaning
A	No bar
B	One bar: there is an area that cannot be skirted, in which significant environmental effects are likely.
C	More than one bar or a broad bar: there is one or more than one area that cannot be skirted in which significant environmental effects are likely.

Table 2: Depiction of the assessment of the remaining area

Hash symbol	Assessment
	Significant environmental effects are potentially possible on a small scale.
#	Significant environmental effects are potentially possible on a moderate scale.
##	Significant environmental effects are likely on a large scale.

2.7 Study of alternatives

Finally, reasonable alternatives are studied. They are examined for their likely significant environmental effects and compared with each other (see above). However, there are limits to a comparison of alternatives,

[2] **Natura 2000 sites are strictly protected under European and national laws since they are highly valuable for particular European habitats and species.**

given the level of abstraction ("high flight altitude") and the level of examination in the federal requirements plan.

3. On the findings: What significant environmental effects are likely?

3.1 Effects on the overall plan

DThe Bundesnetzagentur has examined the likely significant environmental effects of the 65 projects for the target network derived from the 92 measures of the NDP and the O-NDP. These individual measures are examined by way of fact sheets (the fact sheets are shown in the annex available for download at www.netzausbau.de).

Additionally studied are the effects that projects designated in the federal requirements plan as pilot projects for low-loss high power transmission over long distances would have in the form of underground cable. Likewise, the effects of onshore offshore connectors as underground cables are examined and fact sheets drawn up for these.

Figure 3: Structure of the Strategic Environmental Assessment

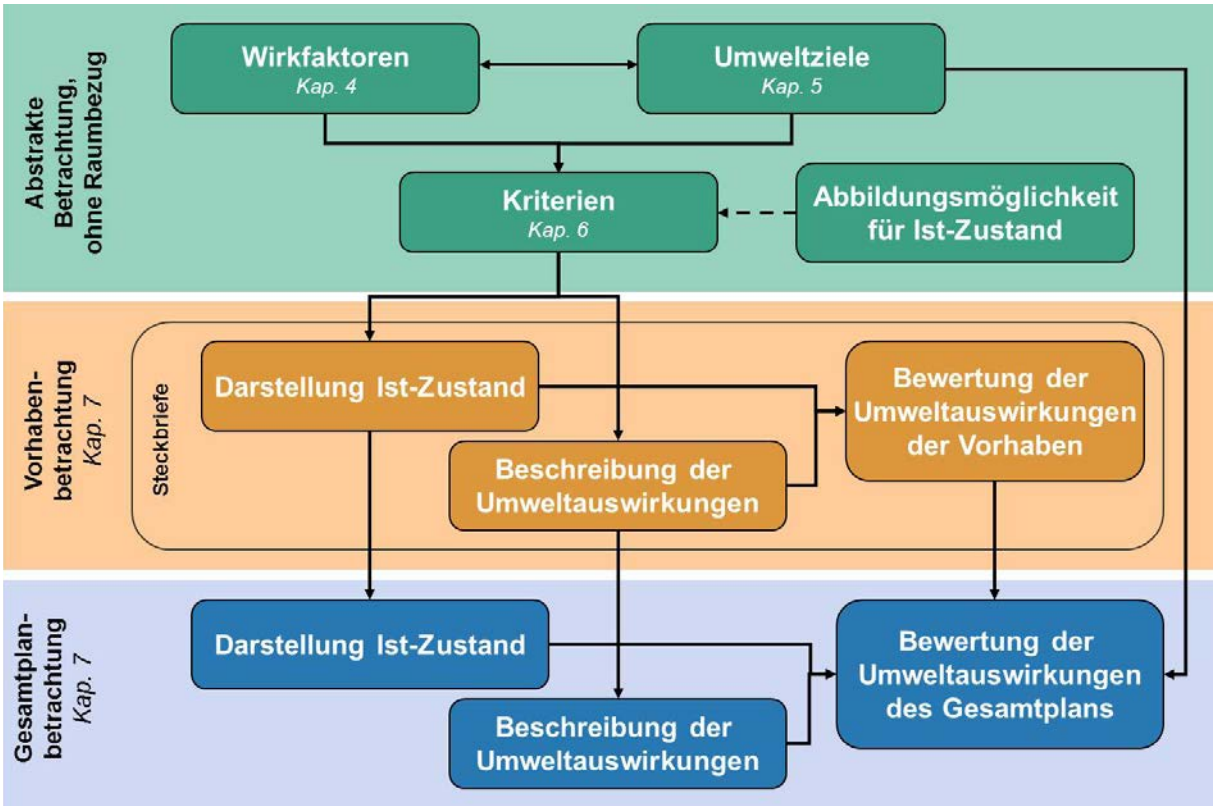
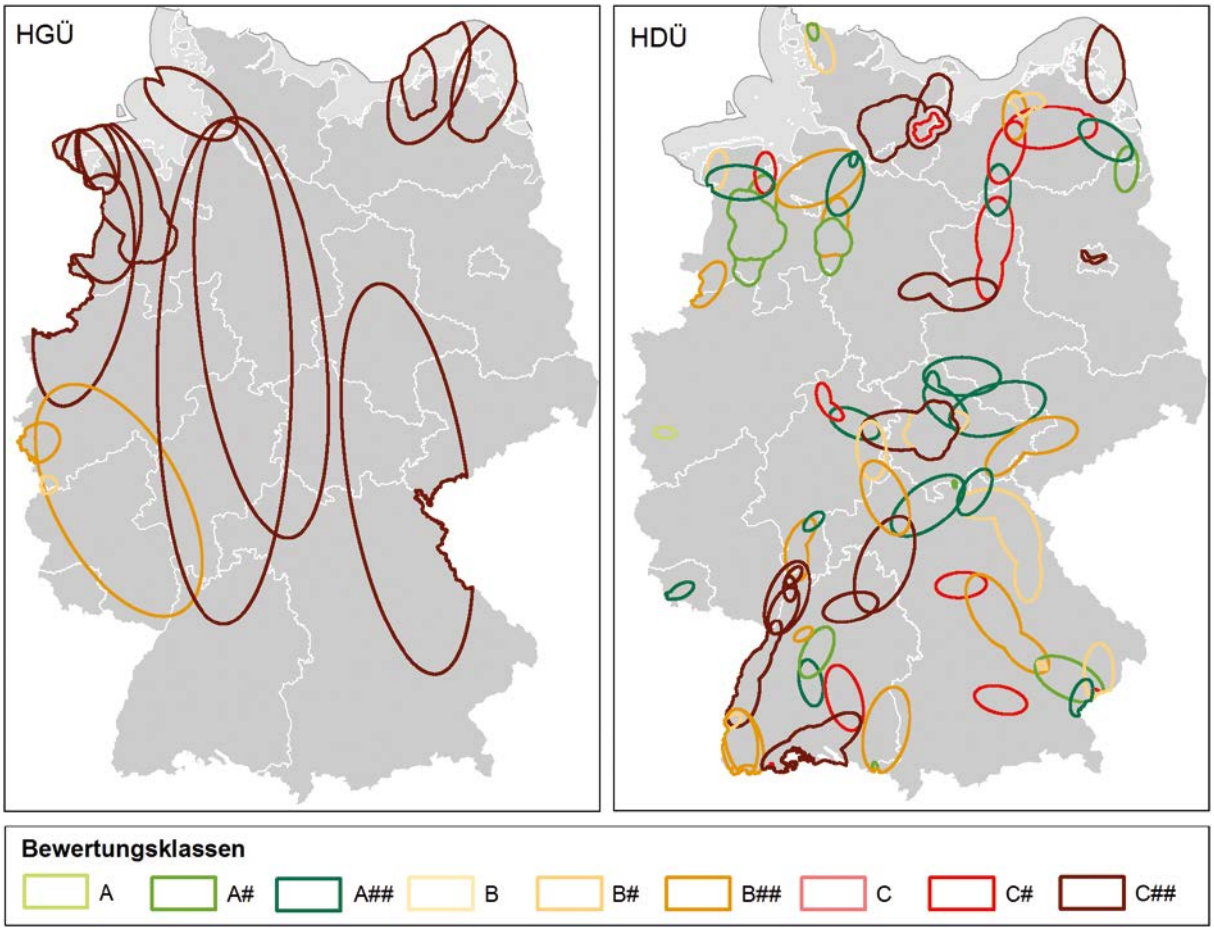


Figure 4 shows how the sub-areas under assessment are evaluated both as overhead lines and as underground cable with the inclusion of all the protected assets: the general survey covering all the protected assets shows that significant environmental effects are likely to be caused by practically all the HVDC measures. Either bars are encountered, that is to say ecologically sensitive areas that cannot be skirted, and/or large-scale significant environmental effects are likely in the remaining area. For the HVAC measures the picture is more strongly differentiated: practically all the assessment spectrum is mapped.

Figure 5 shows the composition of the overall findings for overhead lines and underground cable: 73 percent of the sub-areas under assessment present bars (B and C assessments). In 45 percent of these cases this is either one broad bar or multiple bars (C assessment). 27 percent of the areas under assessment do not show any bars, in other words have no ecologically sensitive areas that cannot be skirted (A assessment). In 1 percent of the cases significant environmental effects in relation to all the protected assets are likely only to a small extent (no hash symbol). For 32 percent of the measures, significant environmental effects are possible on a moderate scale

[3] In the Strategic Environmental Assessment pertaining to the federal requirements plan the Bundesnetzagentur looks only at route measures as far as they do not relate to the area of the Exclusive Economic Zone. Thus the overall number of measures may differ from that in the Electricity NDP 2017-2030 and the O-NDP 2017-2030..

Figure 4: Assessment of measures in the NDP and O-NDP



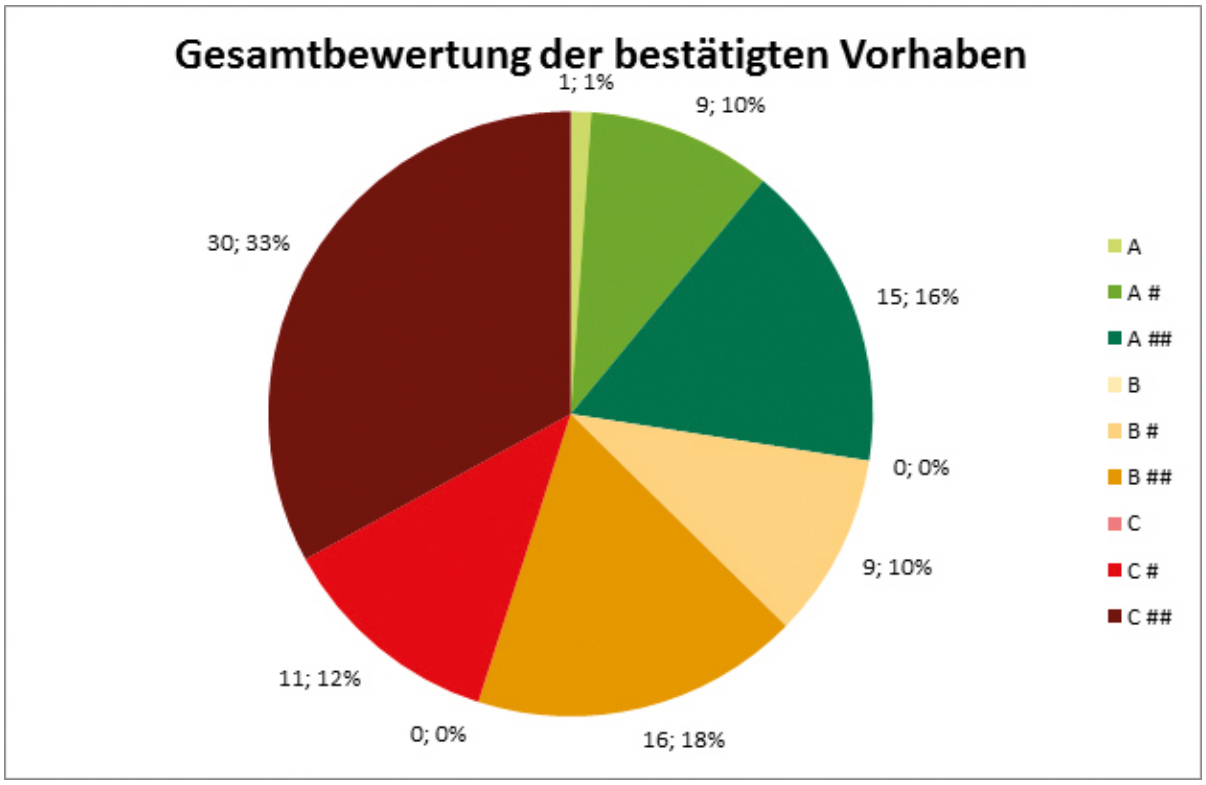
(# assessment) and in 67 percent of the cases large-scale significant environmental effects are likely (## assessment).

Execution with a different technology reveals different assessments of the measures for underground cabling compared to those for overhead lines. With execution as overhead lines, there are, for the most part, fewer and narrower bars (often assessment category B instead of C). This is true especially of the protected assets soil and water. As regards the environmental effects of the connection lines a different technology shows effects ranging from none to only a few on the overall findings for the measures. What does have a significant effect on the assessment, however, is the highly sensitive stretches of land along the coastline. Causing differences are, on the one hand, towns and cities in the sub-area under assessment and on the other, mainland soils that are susceptible to erosion, and waters. Conspicuous in a protected-assets-based survey is above all the greater extent to which the protected assets water and soil are affected when the project is executed as underground cable: whereas no bars are encountered for either asset when the technical execution is overhead line (assessment category A), when it is executed as underground cable bars are found also as a result of the linear structures of flowing waters and certain soil types (assessment categories B and C), and for the protected asset water, even in 61 percent of the measures. However, for these measures, for which execution as underground cabling is also examined, account is not taken of the fact that execution can also be in sections. This can result in different findings than underground cabling along the whole of the route.

It should always be remembered that only very general statements can be made given the rough scale at this surveying level, and that the assumption, moreover, is that of a worst case scenario (see above). At the following, considerably more detailed, stages of federal sectoral planning and planning approval it may be possible to establish that no significant environmental effects are likely or that significant environmental effects can be prevented or at least mitigated by suitable measures; possibly, however, the environmental effects could be greater.

- The areas that are especially likely to suffer environmental effects as a result of the plan are situated mainly as follows: alongside rivers on whose banks

Figure 5: Overall assessment of confirmed projects (number of measures and frequency distribution of assessments)



settlements and land with a high nature conservation ranking (eg nature conservation areas) are often juxtaposed;

- Conurbations with adjacent settlements and valuable nature conservation sites;
- The Limes as a 550km-long UNESCO World Heritage Site, whose linear structure creates a long bar that has to be crossed;
- The start, supporting and end points of the grid expansion measures and any associated sub-facilities that are close to settlements;
- Coastal waters (the assessment of the sub-areas in coastal areas always shows a bar, or one broad / multiple bars on the seaward side on account of the elongated protected areas along the coastline for the protected assets fauna, flora and biodiversity (assessment categories B and C; cf Figure 6)).

Significant environmental effects are also likely on a larger scale in areas in which multiple projects are planned. Affected in particular are the following areas, which have a high density of measures and/or projects:

- Upper Rhine plain with the Rhine-Main and Rhine-Neckar region,
- Coastal waters,
- In Schleswig-Holstein and Lower Saxony, most notably East and North Friesland, Lüneburg Heath and the Wendland, the Altmark, the Black Forest and the Thuringian Forest, the Rhön region, North Hesse, the Kassel – Ludwigsau – Fulda area, the area in and around Stuttgart and the Swabian mountains.

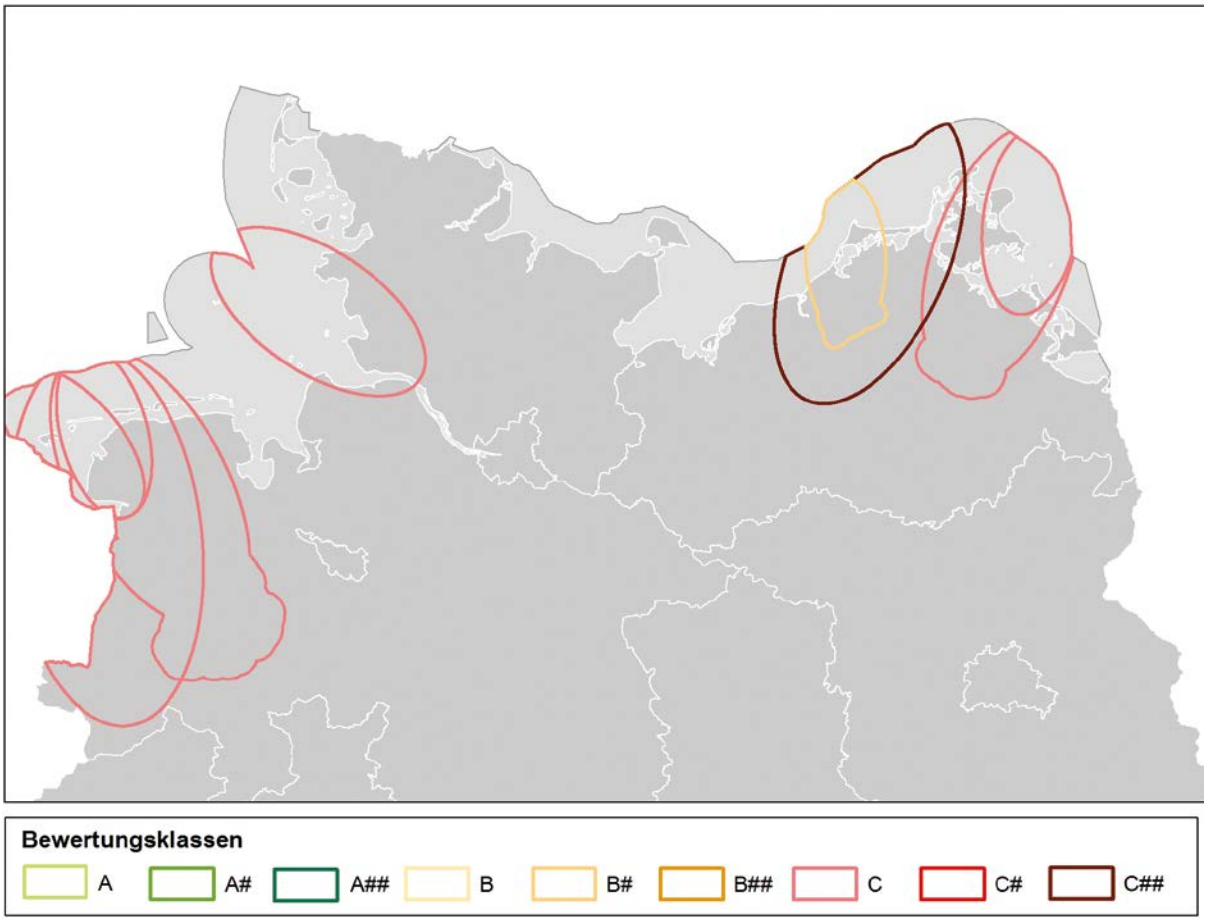
The following extensive, high-sensitivity areas exhibit an average measure and/or project density:

- Tidal / Lower Elbe,
- Lower and middle Weser with Bremen and Bremerhaven,
- Ruhr area and the Rhineland with the fertile plains to the north-east,
- Fichtel mountains, the Regensburg area and along the Bavarian Forest.

Yet the negative effects on the protected assets are also counterbalanced by the indirect positive effects brought about by expansion of the grid as a result of the energy transition. But these are hard to quantify, and cannot be

replicated with the assessment criteria used. They include, for instance, the contribution to meeting climate change

Figure 6: Assessment findings of the NDP and O-NDP measures for the protected assets fauna, flora and biodiversity in the territorial sea (seaward effects)



targets (reducing CO2 emissions), or the contribution to meeting air quality management targets (reducing pollutants through the greater use of renewable energy).

Further, the Bundesnetzagentur has investigated what regions in Germany would be affected to a greater, or to a lesser, extent by the confirmed measures in the NDP and the O-NDP. For this it has established the position and number of measures in spatial-quantitative terms as shown below – without going into protected assets / environmental effects as such. The areas that are highly sensitive to line construction are also shown (see Figure 7). (Rural) districts and self-governing towns are used as the reference.

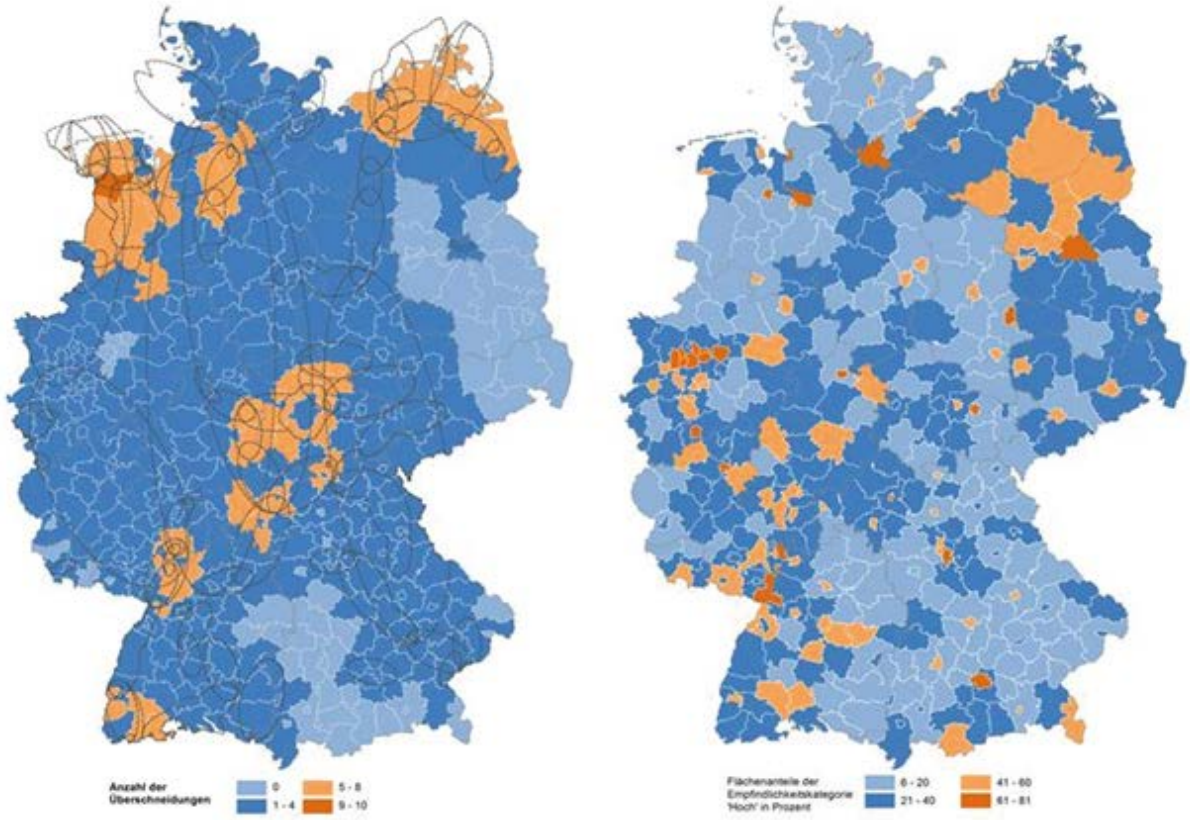
The findings indicate the regions in Germany that would be affected to a greater, or to a lesser, extent by the NDP and the O-NDP measures. The outcome is a worst-case scenario, as not every district that is affected by an overlap of ellipse and district will be affected by the actual expansion of the grid.

As far as areas are specifically affected, environmental effects are (if possible) to be prevented or minimised by applying the NOVA principle. Bundling the course of the routes of similar projects will at least avoid further fragmentation of nature and the landscape.

Figure 7 shows that large parts of Brandenburg, Saxony, the Saarland, parts of Bavaria and small areas of Baden-Württemberg and Mecklenburg-Western Pomerania are unlikely to be affected by grid expansion (shown in light blue). Environmental effects are not therefore expected, generally speaking, as a result of the plan. The second evaluation shows the percentage of areas for which the criteria evidence "high" sensitivity to line construction for districts and self-governing towns. Only in a small number of these districts and self-governing towns does some 50 percent of the area show high sensitivity to grid expansion. This means roughly half of the district has highly sensitive land. A share of over 61 percent of such land is found solely in self-governing towns with a high proportion of residential areas. Yet overall, the analysis shows that in many districts and self-governing towns, land of high sensitivity only occupies up to roughly a quarter of the space. The analysis indicates which areas could be a particular source of conflict with regard to

the planning of further measures at NDP level and to the concretisation of projects, the need for which has already

Figure 7: Areas affected by confirmed NDP and O-NDP measures (left) and percentage of areas of "high" sensitivity (right)



been determined by law. Grid expansion should, as far as possible, avoid areas exhibiting a high percentage in the analysis and being liable to cause conflict in the following stages of planning too. Whether environmental effects can be minimised through observance of the NOVA principle should be investigated. But that is prescribed by law anyway.

3.2 Alternative overall plans

From the vantage point of a survey of all the scenarios the Bundesnetzagentur confirms only those measures that are feasible and sustainable in any case, regardless of future decisions on technologies and which, as a rule, are called for in all the scenarios. Thus confirmation of the network development plan is not made solely on the basis of Scenario B 2030. That is why the study of the alternative overall plans in the draft environmental report has fulfilled its purpose as a basis for discussion of the measures for confirmation in the consultation and is regarded as completed. The environmental report contains a presentation of the findings of this study of alternatives for documentation purposes

3.3 Alternative overall plan: Scenario B 2030

Altogether, Scenario B 2030 covers 156 measures, 144 of which are measures from the NDP and 12 from the O-NDP.

Sixty-five percent of the sub-areas under assessment present bars as defined (letters B and C). In 39 percent of cases these are one broad bar or more than one bar (letter C). Thirty five percent of the areas under assessment have no bar (letter A). In one percent of the cases significant environmental effects on all the protected assets are potentially conceivable on a small scale only (no hash symbol). In 35 percent of the measures, significant environmental effects are potentially possible on a moderate scale (# symbol) and in 64 percent of the cases the assumption is that significant environmental effects are likely to occur on a large scale (## symbol).

3.4 Alternative overall plan: Scenario A 2030

In all, Scenario A 2030 encompasses 148 measures, 136 from the NDP and 12 from the O-NDP. Compared to Scenario B 2030, eight fewer measures in total are considered in Scenario A 2030 – ten are dropped and two are added. There is no change in the offshore measures.

Bars as defined are found in 64 percent of the sub-areas under assessment (letters B and C). In 39 percent of the cases these are either one broad bar or more than one bar (letter C). 36 percent of the areas under assessment present no bars (letter A). For less than one percent of the sub-areas assessed, significant environmental effects on all the protected assets are likely on a small scale only

(no hash symbol). In 36 percent of the measures significant environmental effects are potentially possible on a moderate scale (assessed with #), and in 63 percent of the cases it can be assumed that the grid expansion measures will likely trigger significant environmental effects (## symbol).

3.5 Alternative overall plan: Scenario C 2030

Scenario C 2030 was studied as another alternative overall plan. This scenario comprises 158 measures in total, 146 from the NDP and 12 from the O-NDP. Compared to Scenario B 2030, two measures more are considered in Scenario C 2030, the result of one measure being dropped and three being added. The offshore measures show no changes.

Comparison of Scenarios B 2030, A 2030 and C 2030

Scenario B 2030 presents 156 measures, Scenario A 2030 presents 148 and Scenario C 2030 has 158.

Figure 8 shows the number of measures for each assessment.

With regard to the percentages for the measures in the different assessment categories only slight differences can be noted with shifts of a few percentage points (see Table 3).

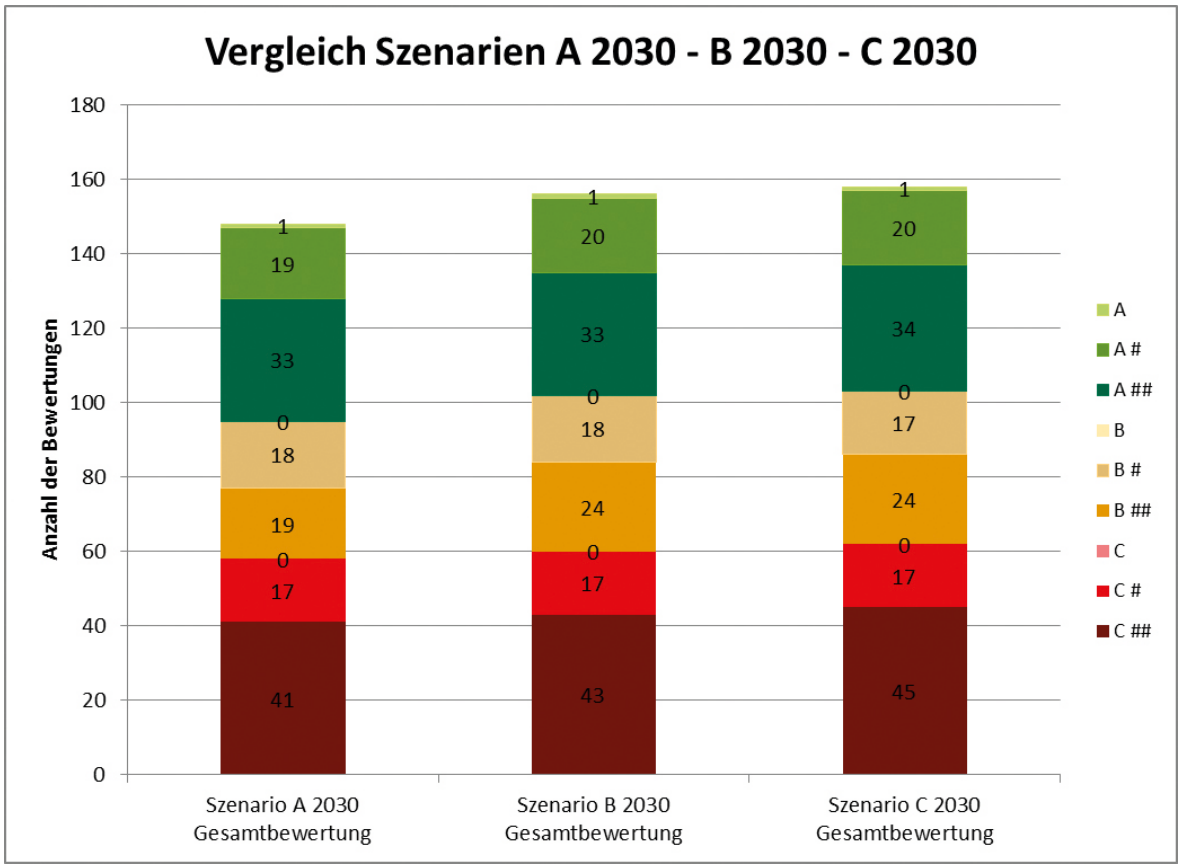
Summarising, we can say the following. Scenarios A and C, compared with Scenario B 2030, have either the same or a very slightly different percentage of assessments designated ## (significant environmental effects are likely on a large scale). The figure in assessment category C (one broad or more than one bar) is one percent higher, while the figure in assessment category A is one percent higher or the same.

Project-specific alternatives

Also studied for their likely significant environmental effects were projects in the second NDP draft that the Bundesnetzagentur had identified as "reasonable alternatives". These relate primarily to such information from the TSOs as is worded in the fact sheets for the proposed expansion projects as "Other planning options".

In its draft environmental report the Bundesnetzagentur examined, for a total of 51 measures, alternative grid connection points and supports – independently of their assessment in terms of energy supply – for their likely significant environmental effects. The revised environmental report now to hand presents

Figure 8: Comparison of overall assessments for Scenarios A, B and C



all the project-specific alternatives to the confirmed projects. These also include the alternatives to the unbundling of the Grafenrheinfeld connection point and use of the alternative end points Urberach (P43mod), Ludersheim (P44mod, AL1-P44) and Mechlenreuth (AL2-P44).

The following alternatives are additions that did not feature in the draft:

- Project 313/Measure 488: Dahlem – Federal border (BE) / Alternative: AL-M488 Gemeinde Rommersheim (near Prüm) – Federal border (BE)

- Project 44/Measure 28a and 28b: Schalkau – Federal state border Thuringia/Bavaria (Mast 77) – Grafenrheinfeld / Alternative: AL4-P44 Schalkau - Mechlenreuth.

- Also shown as a result of confirmation are the offshore measures NOR-3-2 and NOR-7-2 with the end point Hanekenfähr as the new preferred variant and the connections with the end points Cloppenburg / Wilhelmshaven as alternatives.

Not only have the reasonable alternatives undergone specialist environmental study but both the overall assessments and significant differences in the assessments of the individual assets for protection

in the preferred variant and the alternatives studied have been compared with each other. In the consultation the Bundesnetzagentur had specifically requested views on the comparison of alternatives and on distilling an advantage, in environmental terms, according to the criteria set out below. On the whole, the Bundesnetzagentur feels encouraged by the consultation responses to continue with the approach described. It

A, A#, A##	36	35	35
B, B#, B##	25	27	26
C, C#, C##	39	38	39
without hash	1	1	1
#	36	35	34
##	63	64	65

has received a number of comments addressing this issue. To some extent, it has been possible to incorporate concrete proposals in the revised environmental report now to hand. It was also pointed out that a refinement of its benchmarking is planned for the next round of identifying requirements. For this, the Bundesnetzagentur will also seek expert opinions.

The preferred variant and the alternatives are compared in both tabular and cartographic form. Any significant differences in assessment are highlighted by a corresponding rating. Significant differences are present when

- there are two assessment steps (eg A# to C#) between preferred variant and alternative, or

- three protected assets show a difference in assessment of two levels (eg A# to C), or

- the measures in the overall assessment differ by one level (eg B to C##, A# to B##) and there is at the same time a clear difference in length (eg twice the length).

The result of the comparison between the 24 project-specific alternatives and the projects or measures needed to safeguard the energy supply according to the Bundesnetzagentur's examination is as follows: in five cases there is a significant difference in the assessment of the alternatives and hence an advantage for the preferred variant or for one of the alternatives. For the following projects it was possible, with the methodology described, to judge whether either the preferred variant or one of the alternatives showed an advantage from the SEA viewpoint:

- Project 33/M24a Wolmirstedt – Helmstedt – Hattorf – Wahle

- Project P 37/M 25a and M 25b Vieselbach – PSW Talsperre Schmalwasser/Ebenheim – Mecklar
- Project P 44/M 28a and M28b: Schalkau – Federal state border Thuringia/Bavaria (Mast 77) – Grafenrheinfeld
- Project P 185/M 420 Redwitz – Federal state border BY/TH (Point Tschirn)
- Offshore measure OST-2-4/M 73 Baltic Sea Clusters 1, 2, 4 – Cross-boundary corridor I – Municipalities Siedenbrünzow/ Alt Tellin/ Bartow (underground cable on the mainland).

The comparison shows the assessments from the environmental perspective only. If there is no, or only a slight, difference between the preferred variant and the alternative, no assessment of advantage in environmental terms is made. If the study of the environmental aspects shows that a particular measure or one of the available alternatives has an advantage, this is specifically named in the environmental report. The reasons for the environmental advantage of an alternative can be – as described above – both the assessment of individual protected assets (bar, remaining area) and clear differences in length. For the overall picture, further criteria, above all the technical assessment of the measures, must be employed. Documented in the environmental report for information purposes is, in addition to the environmental assessment, the assessment in terms of energy supply and the form of expansion (NOVA category).

Additional aspects may be relevant to consideration of the whole when the plan is adopted by the legislature.

Annex

Listed below are the respondents from public sector bodies (public authorities, administration), societies/federations/associations (incl. parties, churches) and citizens' action groups. Not listed are respondents whose submissions were not made within the consultation period.
Additionally, some companies and more than 14,500 private persons submitted their views in the consultation within the prescribed period.

Public sector bodies
Bauamt Gemeinde Freigericht
Bayer. Staatsministerium für Wirtschaft und Medien, Energie und Technologie
Bundesamt für Infrastruktur, Umweltschutz und Dienstleistungen der Bundeswehr
Bürgermeisterin Stadt Vellberg
Der Gemeindevorstand Petersberg
Der Landrat des Landkreises Nürnberger Land
Gemeinde Aidhausen
Gemeinde Birstein
Gemeinde Bundorf
Gemeinde Burgpreppach
Gemeinde Dörfles-Esbach
Gemeinde Ebersdorf b.Coburg
Gemeinde Ermershausen
Gemeinde Euerbach
Gemeinde Gründau
Gemeinde Hasselroth
Gemeinde Henstedt-Ulzburg
Gemeinde Hetzles über VG Dormitz
Gemeinde Hochstadt a.Main
Gemeinde Kleinsendelbach über VG Dormitz
Gemeinde Königsfeld
Gemeinde Künzell
Gemeinde Lautertal
Gemeinde Motten
Gemeinde Ratekau
Gemeinde Redwitz a.d.Rodach
Gemeinde Riedbach
Gemeinde Schneckenlohe
Gemeinde Stadelhofen
Gemeinde Untermerzbach
Gemeinde Wartmannsroth
Gemeinde Wattendorf

Public sector bodies
Gemeinde Weidhausen
Gemeinde Wilhelmsthal
Gemeindeverwaltung Markt Werneck
Gemeine Petersberg
Großgemeinde Schonungen
Hofheim i. UFr.
Kreis Herzogtum Lauenburg
Kreis Stormarn
Kreis Wesel
Kreisverwaltung Mayen-Koblenz
Landeshauptstadt Wiesbaden - Stadtplanungsamt
Landkreis Bamberg
Landkreis Cloppenburg
Landkreis Emsland
Landkreis Fulda
Landkreis Kronach
Landkreis Lichtenfels
Landkreis Marburg-Biedenkopf
Landkreis Osterholz
Landkreis Schweinfurt
Landkreis Wunsiedel
Landratsamt Bad Kissingen
Landratsamt Bamberg
Landratsamt Forchheim
Landratsamt Gotha
Landratsamt Greiz
Landratsamt Kyffhäuserkreis
Landratsamt Mittelsachsen
Landratsamt Rastatt
Landratsamt Rastatt Amt für Strukturförderung
Landratsamt Schwandorf
Landratsamt Tuttlingen
Main-Kinzig-Kreis, Amt f. Umwelt, Naturschutz u. ländlichen Raum
Markt Wiesenttal
Markt Bad Bocklet
Markt Burkardtoth
Markt Eggolsheim
Markt Heiligenstadt i. 0Fr.

Public sector bodies
Markt Marktgraitz
Markt Mitwitz
Markt Neunkirchen a. Brand
Markt Oberthulba
Markt Roßtal
Markt Zeitlofs
Ministerium für Umwelt, Energie, Ernährung und Forsten
Mitgliedsgemeinden der Verwaltungsgemeinschaft Gräfenberg
Niedersächsisches Ministerium für Ernährung Landwirtschaft und Verbraucherschutz
Niedersächsisches Ministerium für Umwelt, Energie und Klimaschutz
Regierungspräsidium Kassel
Regionale Planungsgemeinschaft Mittelthüringen
Regionale Planungsgemeinschaft Nordthüringen
Regionale Planungsgemeinschaft Südwestthüringen
Regionalverband Nordschwarzwald
Rhein-Kreis Neuss Der Landrat
Stadt Altdorf
Stadt Bad Kissingen
Stadt Bad Staffelstein
Stadt Brandenburg an der Havel
Stadt Coburg
Stadt Fulda
Stadt Heilsbronn
Stadt Hünfeld
Stadt Königsberg i.Bay.
Stadt Kronach
Stadt Kulmbach
Stadt Lichtenfels
Stadt Meerbusch
Stadt Rödental
Stadt Scheßlitz
Stadtverwaltung Eisenach
Thüringer Ministerium für Infrastruktur und Landwirtschaft
Verwaltungsgemeinschaft Bad Brückenau
Verwaltungsgemeinschaft Bad Brückenau - Marktes Schondra
Verwaltungsgemeinschaft Ebelsbach, Bauamt
Verwaltungsgemeinschaft Euerdorf
Verwaltungsgemeinschaft Maßbach

Public sector bodies
Verwaltungsgemeinschaft Steinfeld

Federations and associations
1. SV Römershagen 1949 e.V.
ASV Unterlangenstadt e.V.
BDEW
BUND für Umwelt und Naturschutz Deutschland e.V. Landesverband Schleswig-Holstein
Bündnis Hamelner-Erklärung e.V
CSU Ortsverband Hesselbach
Deutscher Braunkohlen-Industrie Verein e.V.
Evang.-Luth. Pfarramt Weißenbrunn vorm Wald
Freien Wähler Parteilose Liste Freie Wahlgemeinschaft Höchstädt im Fichtelgebirge
Für Mensch und Natur Gegenwind Schleswig-Holstein e.V.
Heimat- und Gartenbauverein Weißenbrunn vorm Wald e.V.
Heimatverein Schleberoda e.V.
Industrie- und Handelskammer Südthüringen
Jagdgenossenschaft Bergrheinfeld
Kirchenvorstand der Evang.-Luth. Kirchgemeinde Weißenbrunn vorm Wald
Landesbund für Vogelschutz in Bayern e.V. (LBV), Geschäftsstelle Coburg
Leave it in the Ground Initiative (LINGO e.V.)
Pro Sinntal e.V.
Regionalverband FrankfurtRheinMain
Regionalverband Neckar-Alb
RhönLink e.V.
Umweltschutzverein Sereetz
Wasserverbandstag e.V.
Zweckverband Naturschutzgroßprojekt Grünes Band c/o Landratsamt Coburg

Citizens' action groups
Aktionsbündnis gegen die Süd-Ost-Trasse
BI - Trassenstopp-Rennertshofen
BI Hünstetten-Wallrabenstein
BI Megatrasse-Lech Niederschönenfeld-Feldheim
Bundesverband der Bürgerinitiativen gegen Suedlink

Citizens' action groups
Bürgerinitiative "Ortsteile Schondra Gegen Südlink"
Bürgerinitiative A7 Stromtrasse NEIN e.V.
Bürgerinitiative Bergrheinfeld sagt NEIN zu Südlink und Folgeprojekten
Bürgerinitiative Der Gegenstrom Elfershausen e.V.
Bürgerinitiative Keine Stromautobahn über Winkelhaid
Bürgerinitiative KIEBITZGRUNDaktiv
Bürgerinitiative Leinburg gegen Gleichstromtrassen
Bürgerinitiative Megatrasse-VG-Nordendorf
Bürgerinitiative Ortsteile Schondra gegen SuedLink e.V.
Bürgerinitiative Speichersdorf sagt NEIN zur Monstertrasse
Bürgerinitiative Weidhausen
Initiative gegen den Doppelkonverter Osterath
Sinntal gegen die Stromtrasse e.V.
Bürgerinitiative Bergrheinfeld sagt NEIN zu Südlink und Folgeprojekten
BI Hünstetten-Wallrabenstein

Respondents from the Czech Republic
Agentur für Natur- und Landschaftsschutz der Tschechischen Republik
Bezirksamt Karlovy Vary (Karlsbad, Tschechien), Abt. Kultur, Denkmalschutz, Bäderwesen und Tourismus
Bezirksamt Ústí nad Labem (Aussig, Tschechien), Abt. Kultur und Denkmalschutz
Bezirksbergamt für das Territorium der Bezirke Plzeň (Pilsen, Tschechien) und des Bezirkes Südböhmen
Bezirksbergamt für das Territorium des Bezirkes Karlovy Vary (Karlsbad, Tschechien)
Bezirksbergamt für das Territorium dwes Bezirkes Ústí nad Labem (Aussig, Tschechien)
Bezirkshygienestation des Bezirkes Ústí nad Labem mit Sitz in Ústí nad Labem (Aussig, Tschechien)
Stadtamt Mariánské Lázně (Marienbad, Tschechien), Abt. Umwelt
Tschechische Umweltinspektion, Gebietsinspektorat Plzeň (Pilsen, Tschechien)
Tschechisches Ministerium für Umwelt, Abteilung Abfall
Tschechisches Ministerium für Umwelt, Abteilung Artenschutz und Implementierung völkerrechtlicher Verpflichtungen
Tschechisches Ministerium für Umwelt, Abteilung Gewässerschutz
Tschechisches Ministerium für Umwelt, Abteilung Luftreinhaltung

Bundesnetzagentur für Elektrizität, Gas,
Telekommunikation, Post und Eisenbahnen
Tulpenfeld 4
53113 Bonn
Telephone:: 0800 638 9 638
www.netzausbau.de

Follow us on twitter.com/netzausbau
Visit us at youtube.com/netzausbau
Find out more at slideshare.net/netzausbau
Subscribe at netzausbau.de/newsletter