

SuedLink

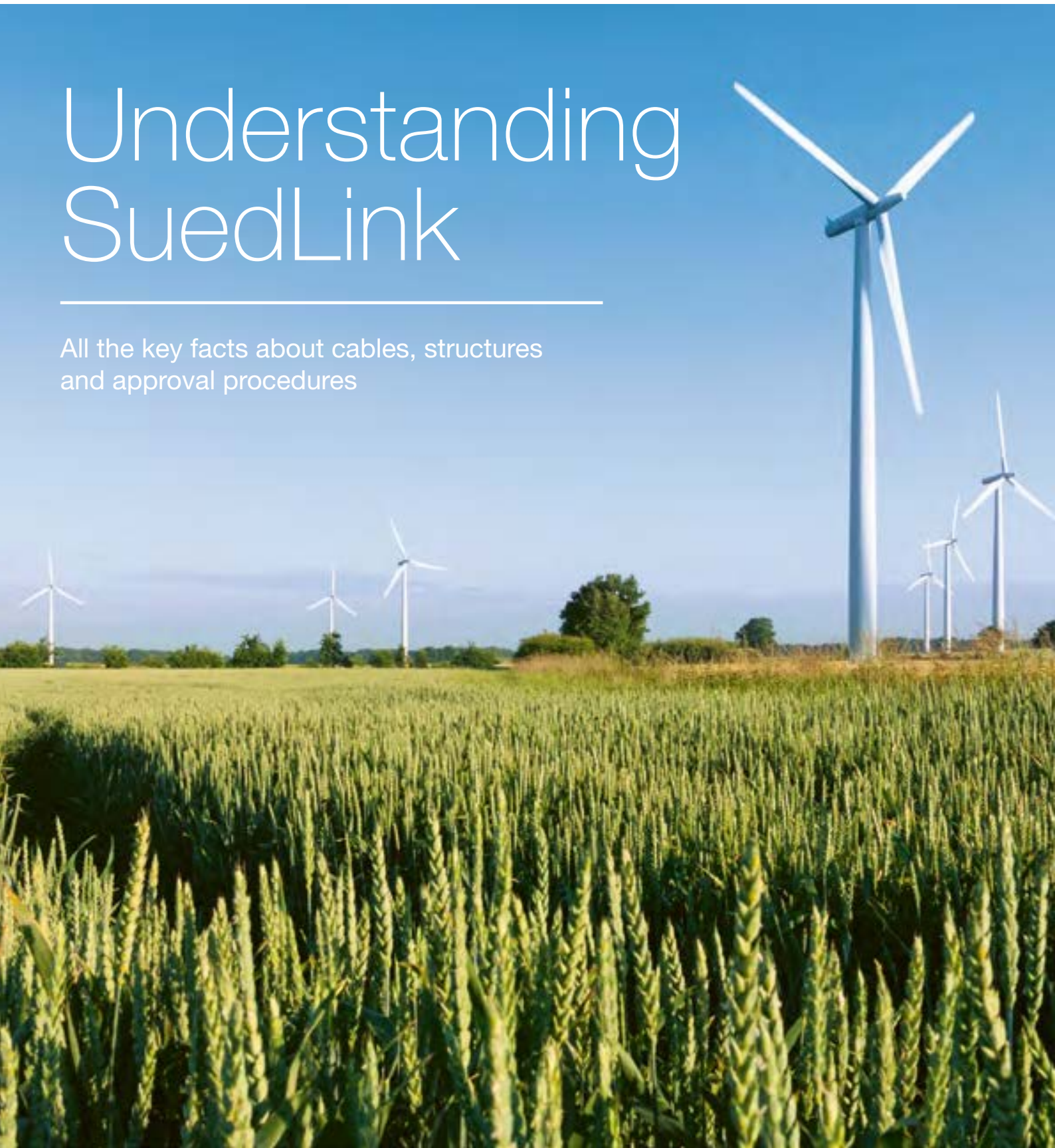
Ein Vorhaben von



TRÄNSNET BW

Understanding SuedLink

All the key facts about cables, structures
and approval procedures





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SuedLink – The Wind Power Line



With a length of around 700 kilometres and a transmission capacity of four gigawatts, SuedLink is the largest infrastructure project of the energy transition in Germany. SuedLink will connect hydroelectric power plants in Scandinavia, wind farms in northern Germany, and solar farms in southern Germany. The connection will enable fluctuating renewable energy sources to be flexibly networked, thereby ensuring a stable and secure power supply.

SuedLink will consist of two high-voltage direct current (HVDC) transmission links stretching from Wilster and Brunsbüttel in Schleswig-Holstein to Bergrheinfeld/West in Bavaria and Grossgartach/Leingarten in Baden-Württemberg. Each of the two connections will be laid as underground cables and have a transmission capacity of two gigawatts. The SuedLink transmission lines will therefore have a combined capacity roughly equivalent to that of four nuclear power plants, and they will be able to supply around 10 million households with electricity. Along with the underground cables, commercial fibre-optic cables will be laid along the entire route. These will particularly offer municipalities in rural areas that are currently still underserved a great opportunity to benefit from high-speed internet. Both underground cable connections are listed in the Federal Requirements Plan Act as separate projects (Project 3 and Project 4). The two transmission lines will run alongside each other over a long distance known as the “combined section”.



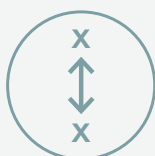
You can find an explanation of the technical terms in the glossary at the end of this brochure.



Two connections – one joint planning

Germany is divided into four control areas with four transmission system operators. Among other things, they are responsible for supplying the distribution grids (e. g. of municipal utilities), reliable grid operation and grid expansion in line with demand. SuedLink is being jointly planned and built by the two transmission system operators TransnetBW GmbH and TenneT TSO GmbH. While TenneT is responsible for the northern section of the SuedLink route as well as the converters in Schleswig-Holstein and Bavaria, TransnetBW is responsible for the southern section and the converter in Baden-Württemberg.

SuedLink is divided into 15 planning approval sections, for each of which a planning approval application will be submitted to the Federal Network Agency. In it, the project developers will apply for the exact route of the transmission line within the corridor that the Federal Network Agency defined at the end of the federal sectoral planning in 2021.



700
kilometres long



10 Power for
m households



4 gigawatt
capacity



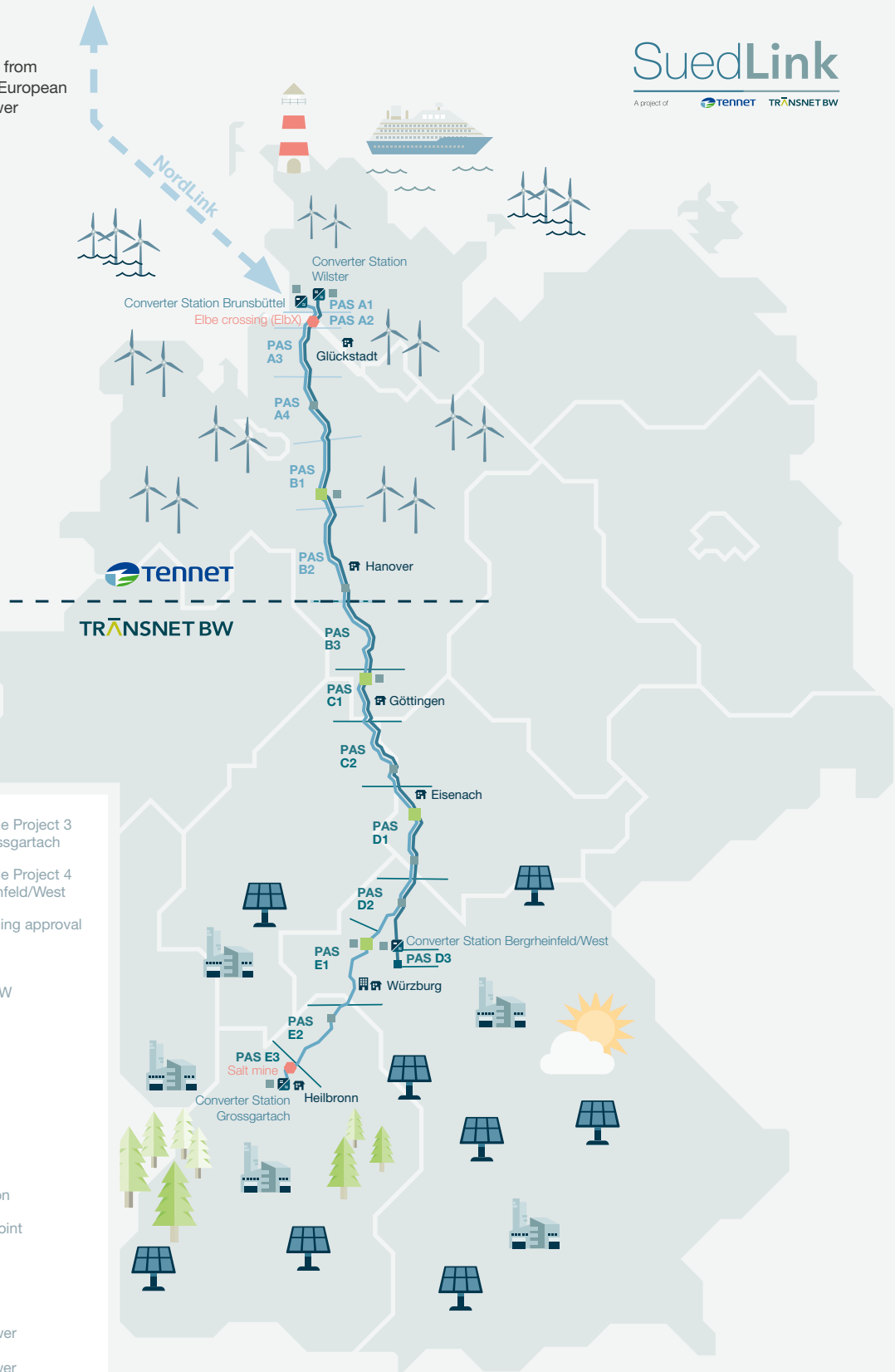
525 kilovolt
voltage



Electricity from
Northern European
Hydropower

SuedLink

A project of  



Route of the transmission line: Status 09/22

- Underground Cable Project 3
Brunsbüttel – Grossgartach
- Underground Cable Project 4
Wilster – Bergheinfeld/West
- Boundary of planning approval
section (PAS)
- Asset Split
TenneT/TransnetBW
- Special structure
- Converter station
with adjacent grid
connection point
- Cable section
station
- Fibre-optic cable
intermediate station
- Grid connection point
- Main office
- Regional office
- Offshore wind power
- Onshore wind power
- Photovoltaics
- Hydropower
- Consumer centres

Route of the transmission line – The main location of the SuedLink team is the joint project office in Würzburg. TenneT and TransnetBW have also set up regional offices to ensure easy access to the SuedLink construction sites as well as proximity to regional contact partners.

Federal law: A key building block of Germany's energy transition

SuedLink is listed in the Federal Network Agency's electricity grid development plan as one of the grid expansion projects for which federal lawmakers see a vital and urgent need so as to ensure secure and reliable grid operation. The grid development plan forms the basis for the Federal Requirements Plan Act (BBPIG). When the Bundestag and the Bundesrat (the two houses of Germany's federal parliament) adopted the Federal Requirements Plan in 2013 (which was last updated in 2021), the need for SuedLink was confirmed by law.

Approval of grid expansion projects that cross the borders of Germany's federal states (Bundesländer), as SuedLink will, is governed by the Grid Expansion Acceleration Act (NABEG). The authority responsible for granting such approvals is the Federal Network Agency.

The federal sectoral planning for SuedLink, which was completed in 2021, defined a 1,000-metre-wide corridor for laying the underground cables that is best suited to minimise any impact on local residents, the surrounding environment and na-

ture. In the second part of the approval process, known as the "planning approval procedure", the exact route for SuedLink will be sought within this corridor. For both steps, the Federal Network Agency will organise (online) application conferences and public hearings at which the public will be able to participate in the planning. The goal is to find the shortest route for SuedLink as well as the one that is the most agreeable to local residents and the environment.



You can find out more about the need for SuedLink in our explanatory film (in German).



Germany aims to be climate-neutral by 2045.

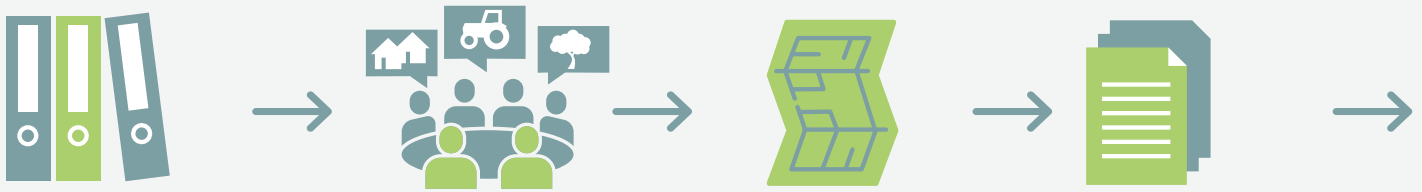
By 2030, the share of renewable energies in gross electricity consumption is to rise to 80 percent.

These ambitious goals of Germany's federal government pose a challenge to the country's electricity grid, as green electricity is mainly generated decentrally in the windy north and sunny south.

SuedLink will provide relief to the grid, make it fit and flexible for the energy transition, and thereby contribute to Germany's efforts to free itself from reliance on fossil fuels.

From the Corridor to the Specific Route: How SuedLink is Being Planned

Planning approval procedure: Searching for the specific route



Project Developers

Submission of application for a planning decision approval pursuant to § 19 NABEG, incl. a well-justified proposal for the specific route as well as alternative routes.

Federal Network Agency

Public application conferences followed by the determination of the investigative scope.

Project Developers

Submission of a plot-specific route plan and the relevant documentation (pursuant to § 21 NABEG) to the Federal Network Agency.

Federal Network Agency

Publication of the documents pursuant to § 22 NABEG.

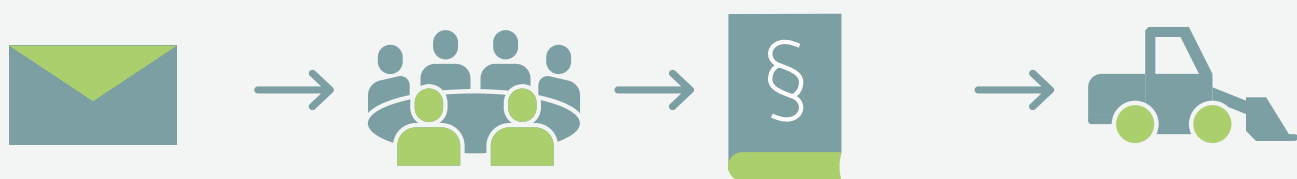
During the planning approval procedure for SuedLink, citizens will be able to submit comments on the planning.

The planning process formally began in 2017 with the **application for federal sectoral planning**. In this application, the two project developers presented initial corridor proposals, which were examined in more detail and further developed during the federal sectoral planning. Even before the formal procedure had begun, TransnetBW and TenneT got the public involved in developing the corridor proposals in addition to collecting, evaluating and responding to around 19,000 planning-related comments.

With public participation, the Federal Network Agency made a binding decision on an uninterrupted, 1,000-metre-wide corridor for SuedLink. With this decision pursuant to § 12 NABEG, the federal sectoral planning was concluded.

The second part of the approval process, the **planning approval**, represents the conclusion of the planning process. Owing to SuedLink's length of around 700 kilometres, the overall project was divided into 15 planning approval sections. Since February 2020, pursuant to § 19 NABEG, TransnetBW and TenneT have successively submitted to the Federal Network Agency an **application for a planning approval** decision for all the sections. The documents include an initial proposal for a route for the underground cables as well as potential alternatives. The proposed routes lie within the already-specified corridor. This phase has been completed for all of SuedLink's planning approval sections.

After receiving the applications for the planning approval decision, the Federal Network Agency held application conferences



Public

Submission of comments to the Federal Network Agency: Interested parties and public-interest bodies may submit objections and comments within one month of the expiry of the public display period.

Federal Network Agency

Public hearings on the objections and comments.

Federal Network Agency

Planning approval decision (pursuant to § 24 NABEG): Determination of the cable route. This can be viewed on the internet and will be made public.

Project Developers

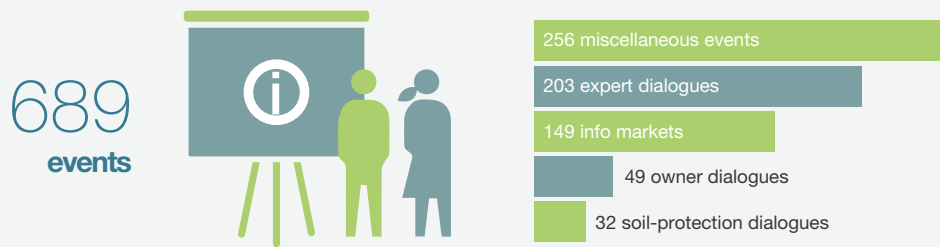
Start of construction.

as part of the formal procedure (§ 20 NABEG). Here, the public and public-interest bodies were able to submit comments on the proposals. Based on the results, the Federal Network Agency finalised the contents of the **planning approval documents** and defined the **investigative scope**. The latter specifies which additional data – gathered, for example, by mapping plant and animal habitats or conducting subsoil investigations – still need to be collected in order to find the most agreeable route for the underground cables within the corridor. This approval step has also been completed for all 15 planning approval sections.

In the subsequent planning phase, the project developers will carefully examine the various alternatives – while taking public and private concerns into account – in order to find the best possible route for SuedLink. As part of this, TransnetBW and

TenneT will submit planning approval documents to the Federal Network Agency in accordance with § 21 NABEG. Among other things, the documents will contain the exact plot-specific route of the transmission line, the required building sites, protective measures and construction-related specifications. In addition, the documents will contain information on alternative routes. The Federal Network Agency will publish the documents on the internet and discusses them with interested parties and public-interest bodies (§ 22 NABEG). Based on this hearing, the Federal Network Agency will issue the planning approval decision and, with it, the permit to build SuedLink. SuedLink will be built in sub-segments no longer than two kilometres. The average time needed to build each segment will be 12 weeks. After about four years of construction, SuedLink will enter service in 2028.

Public participation during the federal sectoral planning process



In autumn 2016, public feedback led to 28 major changes to the corridors as they stood at the time.

19,000
planning-related
comments

were gathered,
examined and answered during
the first approval procedure.



13,659
enquiries from citizens

1,216 letters
2,794 emails
2,000 calls
7,649 online enquiries

3 Documents in the Planning Approval Procedure

In order to obtain the permit to build SuedLink, TransnetBW and TenneT are submitting a detailed permit application in accordance with § 21 NABEG. This has 13 parts:

Part A

Explanatory Report

At the beginning, the project is summarised. Part A describes and states the reasons for the project – effectively as a summary of the documents.

Part B

Consideration of Alternatives

In a complex process, in-depth consideration is given to where the underground cables will run. Part B presents all the examined alternative routes and explains why the preferred route was chosen.

Part C

Engineering & Route Planning

Part C contains the technical explanatory report as well as plans and listings of all technical installations, structures, special structures and crossings.

Part D

Securing of Legal Rights

Part D describes the plots of land that will have to be utilised for SuedLink and how this will be done.

Part E

Expert Opinions (on Ambient Pollution)

Part E contains expert opinions on electric and magnetic fields as well as on the noise, vibrations, heat, light and airborne pollutants.

Part F

Environmental Impact Report

Building infrastructure has an impact on residents, the surrounding environment and nature – the so-called “objects of protection”. Part F describes these impacts.

Part G

Natura 2000

Natura 2000 is an EU-wide network of protected areas established in 1992. The impacts on these protected areas are assessed individually in Part G.

Part H

Protection of Species

Assessments of potential impacts on wildlife or protected species are provided in Part H.

Part I

Landscape Management Plan

The Federal Nature Conservation Act stipulates that any impacts on nature and the landscape must be offset. As Part I of the planning approval documents, the landscape management plan calculates the needed offsetting as well as the measures it will entail.

Part J

Technical Paper on the EU Water Framework Directive

Part J assesses the project’s compatibility with the objectives of the EU Water Framework Directive.

Part K

Related Permits, Authorisations and Exemptions

Part K deals with permits and approvals required under building, water, forestry, road, monument-protection, river and shipping-police law as well as exceptional permissions and exemptions required under nature conservation law.

Part L

Additional Expert Appraisals and Concepts

Additional expert appraisals, concepts and other documents can be found in Part L. These include reports on soil protection and archaeological monument preservation as well as the results of geotechnical investigations.

Part M

Documentation of Data

The final part, Part M, contains the data and information used in preparing the planning approval documents.



Criteria for determining SuedLink's route

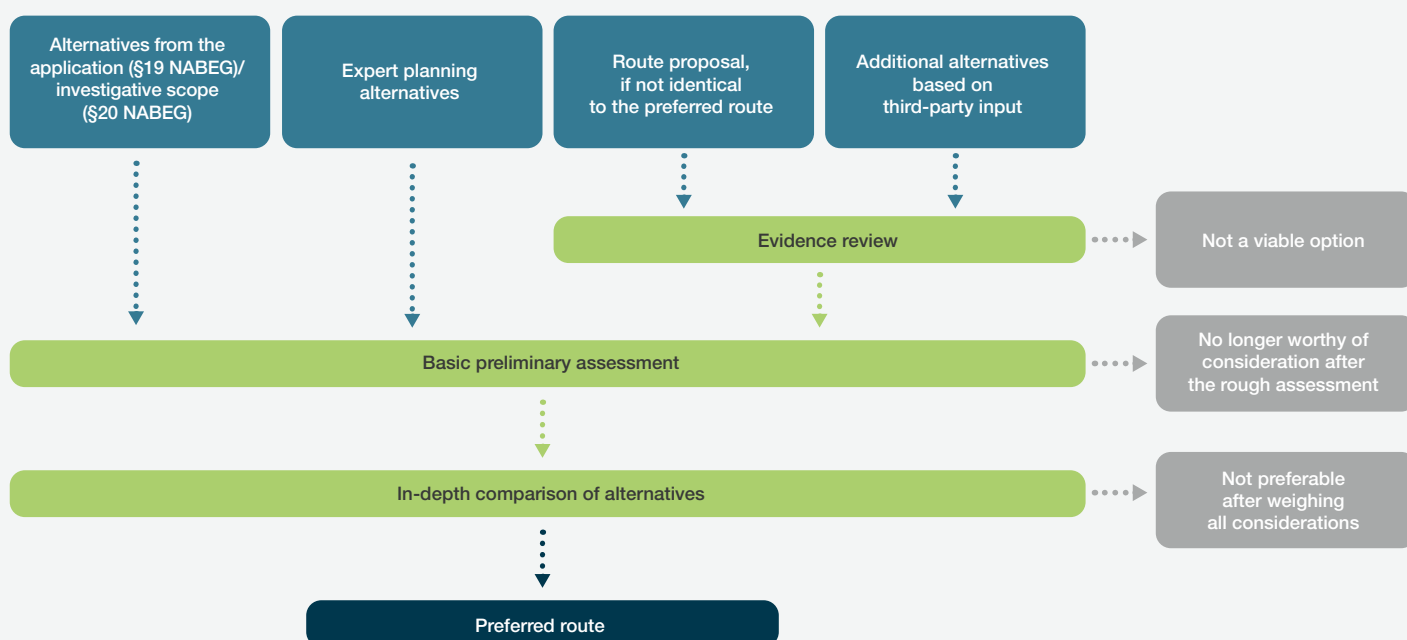
So-called routing principles will ensure that the proposed cable route will be acceptable in terms of its impact on the physical surroundings and environment:

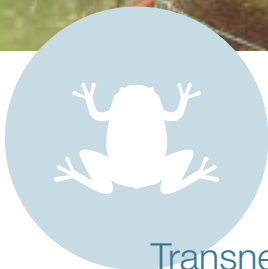
- » the shortest possible, unbent route with the lowest possible impact on the environment and nature,
- » safe routing,
- » cost-efficient routing,
- » bundling with other linear infrastructure elements (e.g. gas or telecommunication lines),
- » parallel routing of Project 3 and Project 4 as much as possible along one combined section
- » ensuring safe and reliable operation,
- » building the transmission lines in a way that minimises the risks involved in their technical realisation

Examination of alternative SuedLink routes

In addition to an initial proposal for a route for SuedLink, the application for a planning approval decision will also include alternative routes. They will be derived from the Federal Network Agency's investigative scope, from input provided by the public, and from the opinions of experts while the planning is progressing. There will be a set, three-step procedure for assessing the alternatives:

- 1. Evidence review:** Alternatives that demonstrably do not meet specifications or do not offer any obvious advantages will be discarded.
- 2. Basic preliminary assessment:** Alternatives that are not desirable even on the basis of a rough assessment will be discarded.
- 3. In-depth comparison of alternatives:** Alternatives deemed worthy of further consideration will be weighed on the basis of in-depth data.





TransnetBW and TenneT are mapping the habitats of wildlife (e.g. the northern crested newt) to ensure that the route of the transmission line is designed to minimise any impacts on the natural environment as well as on rare or endangered species.

4 The Engineering of SuedLink

High-voltage direct current (HVDC) transmission – efficiently transporting power over long distances

Direct current transmission lines like SuedLink are generally laid as underground cables. TransnetBW and TenneT have decided to lay innovative 525-kilovolt cables.

Renewable energies fluctuate greatly in terms of their electricity production. High-capacity HVDC transmission using 525-kilovolt cables will help to bundle the locally produced green electricity and integrate it flexibly into the power grid. Using this technology makes it possible to better control load flows in the grid – in other words, how much electrical power is transmitted

between two nodes. In addition, the amount of power lost during transmission is lower than with comparable alternating-current (AC) lines. This enables renewable energies to be transported flexibly and efficiently over long distances.

Along SuedLink's combined section, two pairs of cables – each with a positive and a negative pole – will be laid in two adjacent trenches. Since the two transmission lines will have different end points, the two cable systems will be laid separately at the ends as single-line sections.



Up to two kilometres of cable fit on a single reel.



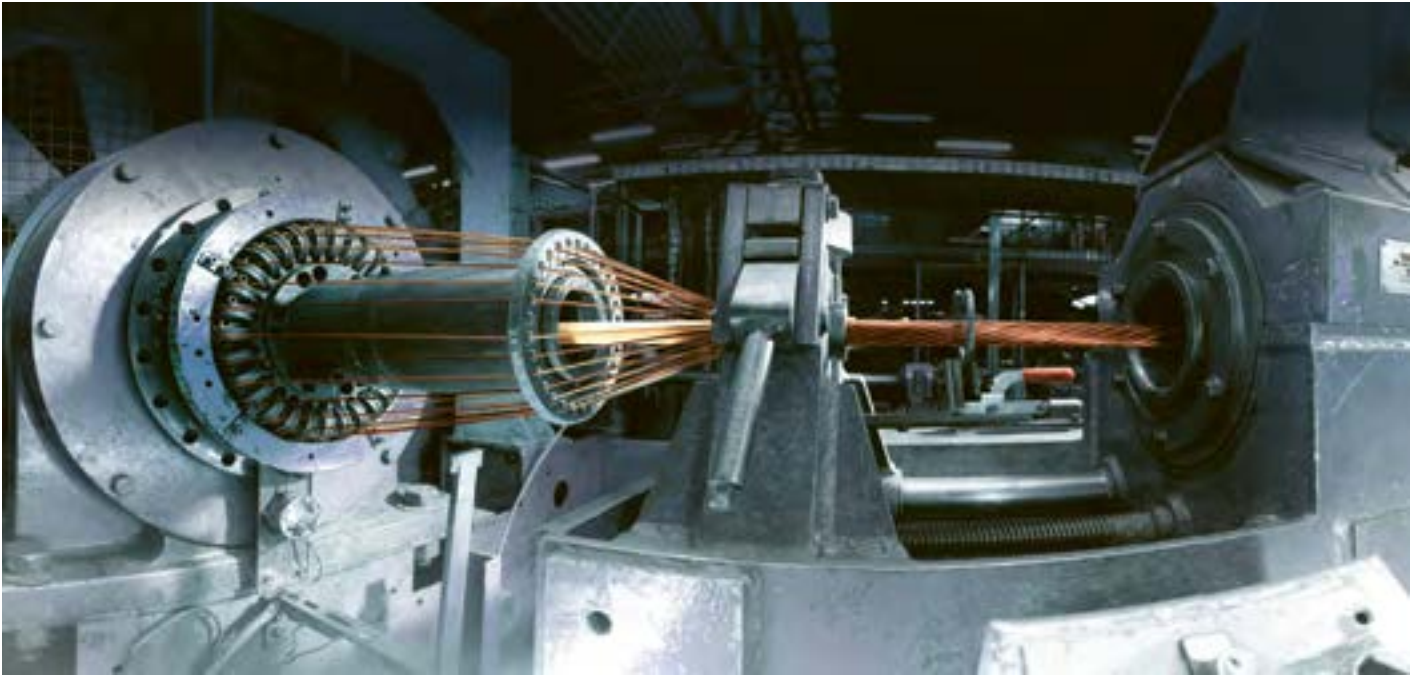
Advantages of 525-kilovolt high-voltage direct current (HVDC) transmission

- » Transmission losses are lower when transporting electricity over long distances.
- » High transmission capacity: Only half of the cables (compared to 320-kilovolt DC cables) are needed to transport four gigawatts of electrical energy.
- » Having fewer cables also lowers any impacts on local residents, the surrounding environment and nature.
- » The flexibility and system stability of the electricity grid are boosted.
- » Load flows in the grid can be better controlled.
- » The fluctuating generation of electricity from renewable sources can be better integrated into the power grid.

Design of the underground cables

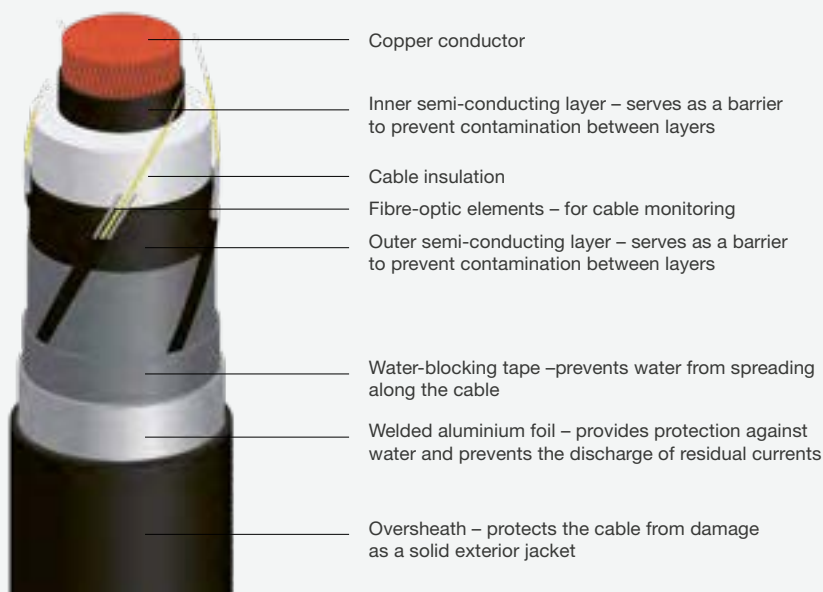
SuedLink's underground cables will have a diameter of around 15 centimetres. They will consist of multiple layers, each of which will play a specific role. For example, while some layers will ensure that the energy is transported at low loss, others will shield the energy transmission from the ground so as to allow the soil to be used after construction and farmed again as before with few constraints. The cable ends will be connected to each other by so-called jointing.

Direct current cables will only generate static magnetic fields because the electric fields will be shielded by the cable sheathing. The static magnetic field will be well below the legal limit even directly above the cable. In our everyday lives, we are surrounded by much stronger magnetic fields, such as those found on trams and trains.



SuedLink's cables are being manufactured in Europe by the two European companies NKT and Prysmian.

SuedLink's cables will have a diameter of roughly 15 centimetres



Ensuring that the electricity arrives safely: technical ancillary facilities

The underground cable itself will not be visible from the surface. Above ground, one will be able to see converter stations and their overhead line connections to the grid connection points, such as electrical substations. Also envisioned are link boxes for measuring and earthing points, cable section stations and fibre-optic repeaters stations.

These technical facilities are needed to ensure that SuedLink's underground cables can be operated safely and without disruption. Among other things, it will be possible to use them to monitor the condition of the cables around the clock and to quickly locate and rectify any possible faults. TransnetBW and TenneT will build the technical facilities on or in the direct vicinity of SuedLink's underground cables.

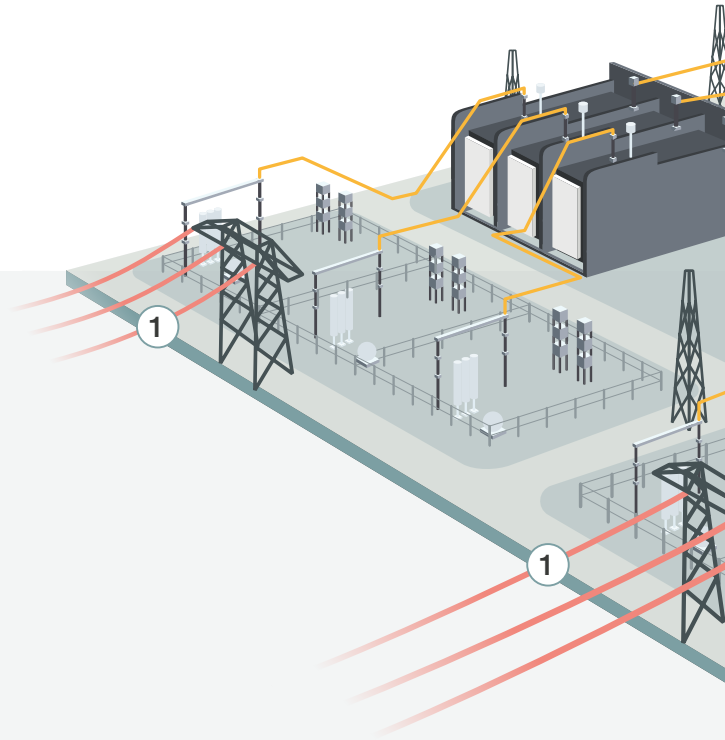
Four kinds of technical structures playing different roles

Converters convert alternating current into direct current – and vice versa

Since Germany's national power grid is based on alternating current, it will be necessary to convert the alternating current into direct current and vice versa. This will be done in the converters that will be built at SuedLink's starting and ending points in northern and southern Germany.

The site of each converter station will cover up to seven hectares (17.3 acres). On these sites, there will be halls around 20 metres high housing the power electronics and other technical equipment, such as transformers, ventilation systems and cooling units. The outdoor facilities will be comparable to those of an electrical substation and extensively planted with greenery. The locations of these sites were selected with input from local residents.

While TenneT is planning three SuedLink converter stations at the grid connection points in Brunsbüttel and Wilster in Schleswig-Holstein and at the grid connection point Bergheinfeld/West in Bavaria, TransnetBW is planning one at the grid connection point in Leingarten (Grossgartach) in Baden-Württemberg. Pursuant to the Federal Immission Control Act, each of the converter stations will be applied for in a separate procedure and not as part of the planning approval procedure.



1 Connection to AC power grid

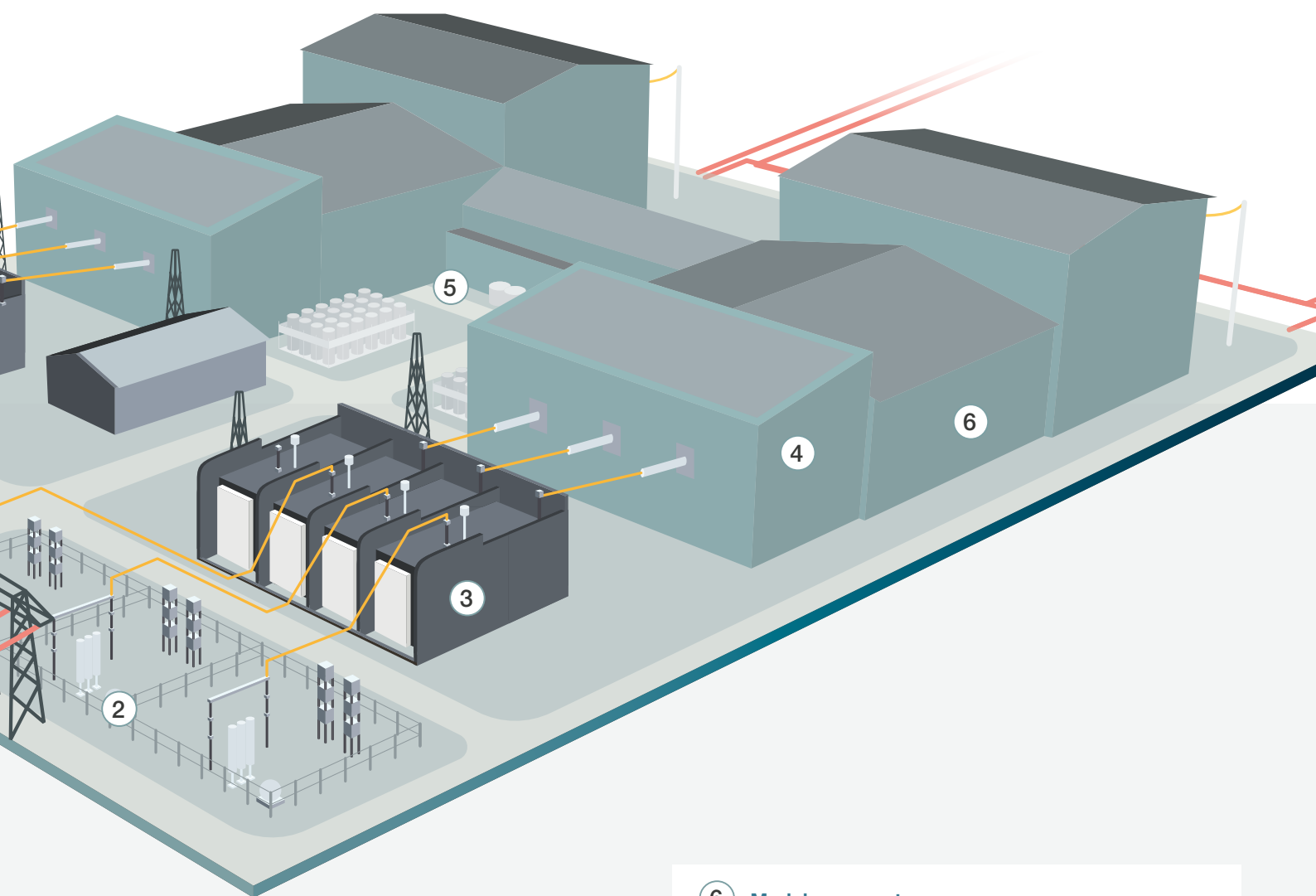
A 380-kilovolt AC power line connects the AC power grid to the converter station via an electrical substation.

2 AC switchgear

In the switchgear, the voltage and strength of the current are measured to prevent damage to the system.

3 Transformers

The transformers connect the converters to the AC grid. They adjust the grid voltage to the required input voltage of the converters.



4 Smoothing reactors

Smoothing reactors protect the converters from excessive current that can be caused by faults and circulating currents.

5 Valve hall

Waste heat is generated by the numerous switching processes. This is dissipated in the cooling system of the valve hall.

6 Modular converter



The hall housing the converter is the core element of the converter station. Here, alternating current is converted into direct current and vice versa.

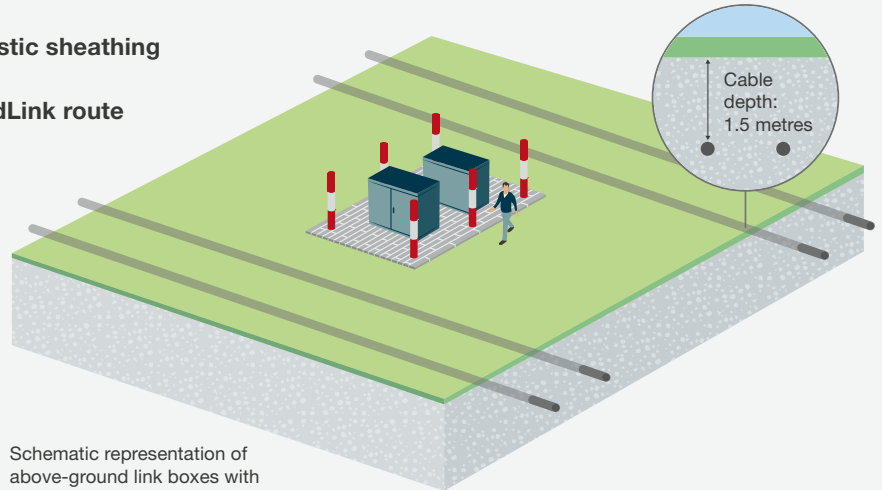
Link boxes ground the cable sheathing and enable faster fault location

Link boxes make it possible to locate faults more quickly. For this, the sheaths of the cables are fed into the link boxes every few kilometres via earthing cables in order to earth the cable sheathing. This is important because the cable shield can become charged with electrical energy, for example as a result of a lightning strike or a short circuit. This energy must then be dissipated so as to prevent an electric shock.

The roles played by link boxes

- » measuring to ascertain that the plastic sheathing of the cables is undamaged
- » locating cable faults along the SuedLink route
- » maintenance

The link boxes will be built at intervals of about 10 kilometres and in direct proximity to the jointing. Generally constructed above ground, they will only take up a few square metres of space. If necessary, bollards will be placed around the link boxes to protect them.



Schematic representation of above-ground link boxes with protective bollards

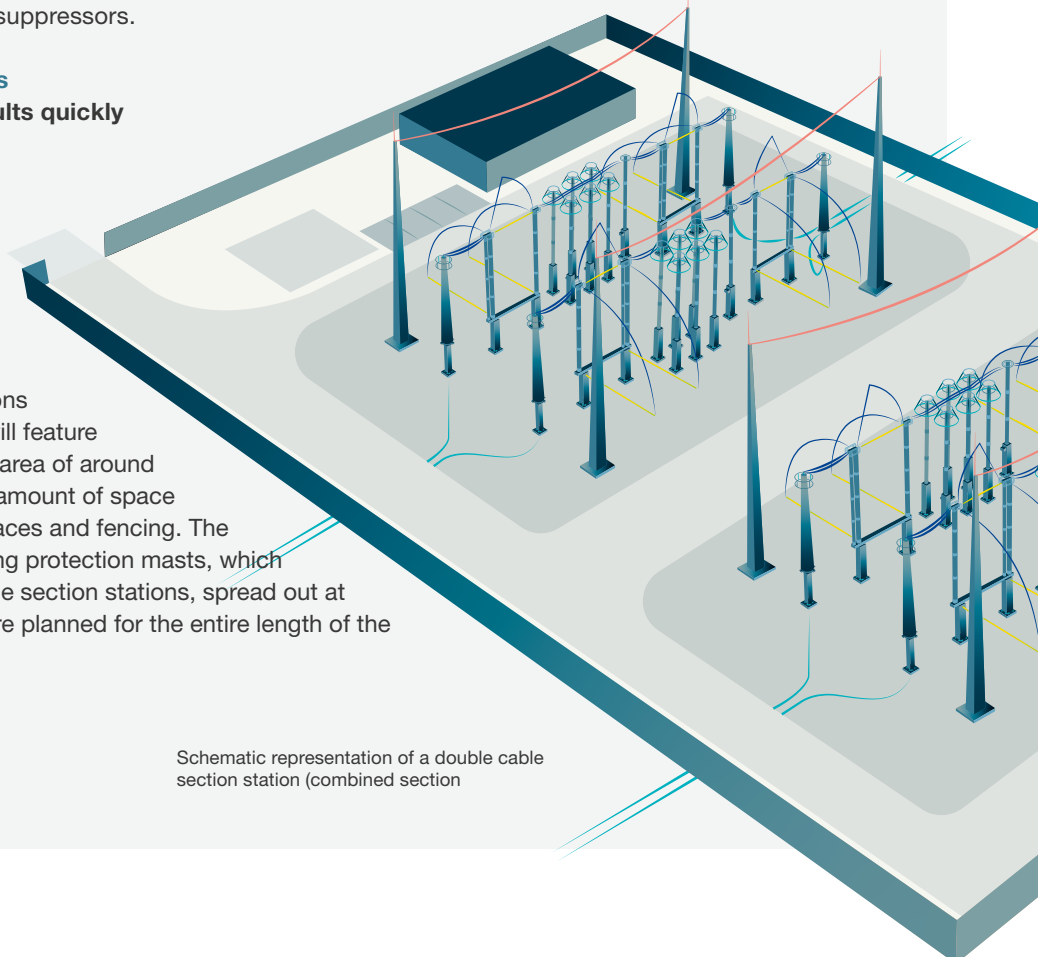
Cable section stations will make it possible to quickly and precisely locate any faults

The cable section stations will serve as disconnection (i.e. cut-off) points to quickly and precisely locate cable faults, such as ones that may occur at the connection points of the individual cable sections. Each individual cable section station will contain various high-voltage devices, such as disconnectors, earthing switches, current transformers, voltage dividers and surge suppressors.

Roles of the cable section stations

- » locating and rectifying cable faults quickly
- » ensuring reliable operation
- » reducing potential downtimes

About 5,000 square metres – or a bit less than the area of a football pitch – will be needed to install each cable section station along the single sections. The double cable section stations along the combined section, which will feature four cables per system, will cover an area of around 10,000 square metres. However, the amount of space required may vary owing to green spaces and fencing. The tallest components will be the lightning protection masts, which are about 27 metres high. Seven cable section stations, spread out at intervals of roughly 135 kilometres, are planned for the entire length of the SuedLink line.



Schematic representation of a double cable section station (combined section)

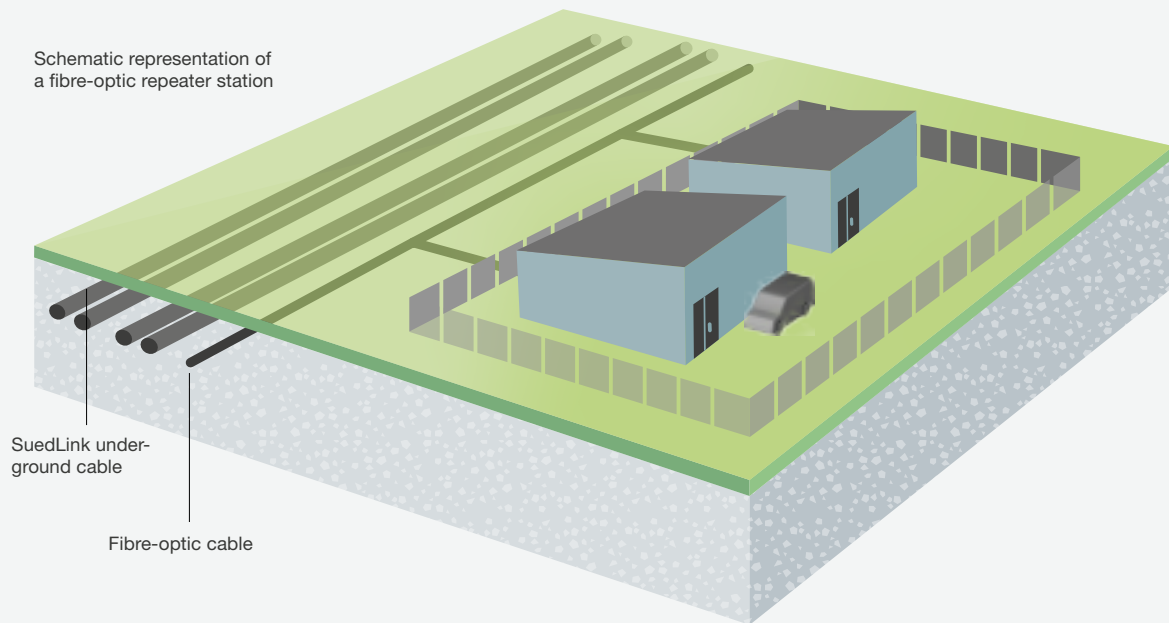
Fibre-optic repeater stations will amplify the operating signals

The fibre-optic repeater stations will help to monitor the functioning of SuedLink's underground cables. Since the quality and strength of the signal in the optical fibres (i.e. fibre-optic cables) decrease as the SuedLink line becomes longer, the repeater stations will amplify the signal and feed it back into the optical fibres.

Role of the fibre-optic repeater stations

- » transmitting operating signals between the grid connection points and the converters
- » monitoring of cable conditions (e.g. via temperature measurements)
- » locating faults quickly

Schematic representation of a fibre-optic repeater station



The optical fibres will be integrated into the underground cables as well as laid alongside them. The equipment of a fibre-optic repeater stations will be installed in two places – namely, in the cable section stations and between the cable section stations as stand-alone stations that will be established at least every 75 kilometres along the course of the SuedLink transmission line. Given that SuedLink will be 700 kilometres long, this means that there will be five stand-alone fibre-optic repeater stations as well as four repeater stations integrated into cable section stations. Including their safety buffer zone, they will require about 500 square metres along the single sections and about 1,000 square metres along the combined sections.

5 Construction & Logistics

How equipment and materials will get to the construction sites

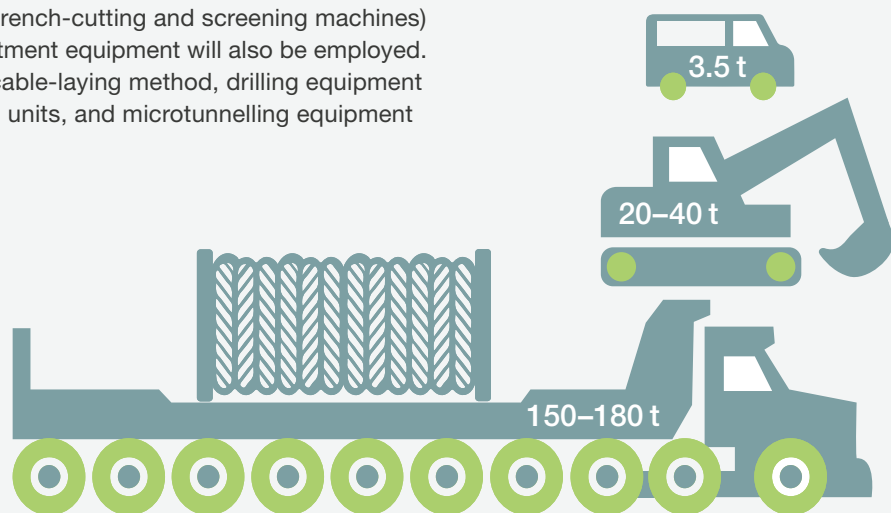
To build SuedLink, it will be necessary to transport equipment and materials to the construction sites. To do so, both project developers will be using public roads as much as possible. Where necessary, roads and bridges will be reinforced and lanes and access roads upgraded. Along local through-roads, it may also be necessary to temporarily relocate street signs, traffic lights and free-hanging cables. Once the transports have been completed, the roads will be returned to their original states. TransnetBW and TenneT aim to obstruct public transport and the movements of local residents as little as possible. If roads classified lower than district (i.e. country) roads are needed, TransnetBW and TenneT will conclude usage agreements with their owners.

Temporary construction roads will be built to access the work strips from the road. In the course of all this, the project developers will closely coordinate their activities with the responsible authorities, municipalities, landowners and land managers. During construction, the building equipment will be transported on the construction road along the working strip. The heaviest objects on the construction sites will be the cable transports, as the cable reels and their transport vehicles will have a combined weight of up to 180 tonnes (see graphic).

After construction, all site facilities, storage areas, construction roads and access roads will be dismantled or returned to their original states. During the recultivation phase, TransnetBW and TenneT will closely coordinate their activities with the owners and managers of the land.

Vehicles and their weights on the construction site

In addition to standard earthmoving machines (e.g. excavators, wheel loaders and bulldozers), special machines (e.g. trench-cutting and screening machines) as well as special transport and soil-treatment equipment will also be employed. When using the trenchless (i.e. closed) cable-laying method, drilling equipment of various sizes, pipe jacking and boring units, and microtunnelling equipment will mainly be used.



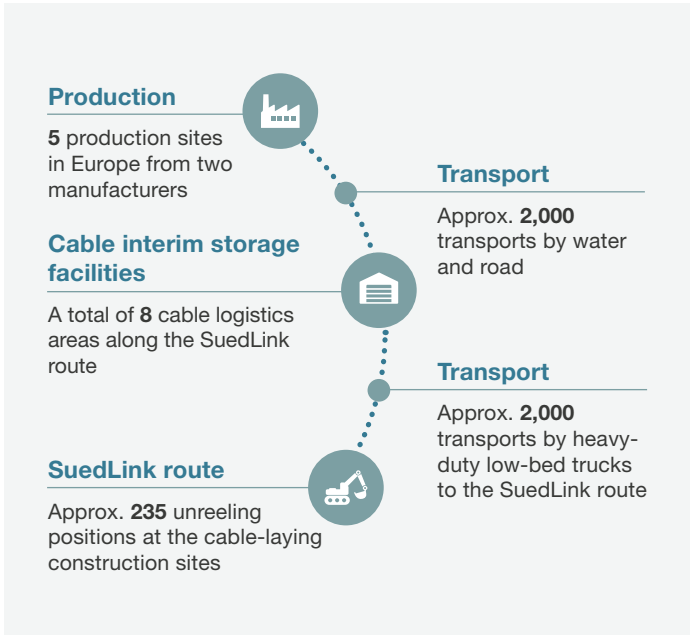
(Maximum load per axle: 12 t)



Heavy and bulky items will be transported on approved routes in the low-traffic period between 10 pm and 6 am.

The SuedLink cable: continuously delivered, installed in stages

In addition to construction machinery and materials, the underground cables will also have to reach the construction sites. The two cable manufacturers, NKT and Prysmian, will produce a total of 2,420 kilometres of cable for SuedLink. While NKT will supply cable from Cologne and Karlskrona (Sweden), Prysmian will do so from Gron and Montereau (both France) as well as Pikkala (Finland). The finished cable sections, measuring up to two kilometres long, will travel by ship and heavy-duty low-bed trucks to the cable interim storage facilities. The cable reels will arrive regardless of the progress of construction – which will pose a logistical challenge.



Cable interim storage facilities: smartly positioned, closely guarded

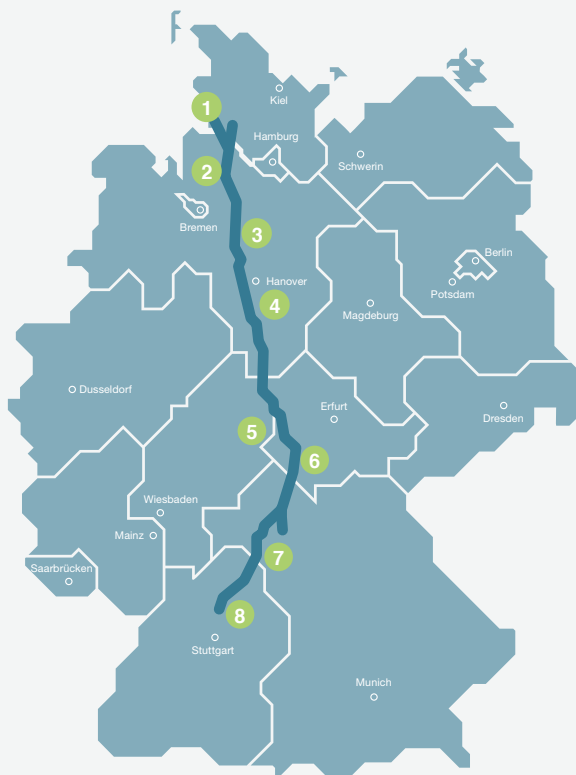
The cable reels will make the first stop on their journey at the cable interim storage facilities. As soon as the cable segments are needed, heavy-duty low-bed trucks will deliver the reels to the unreeling locations on the SuedLink construction sites. Generally speaking, the underground cables will be transported on classified roads, such as federal, state and district roads. If this is not technically possible or practical, non-classified roads (e.g. dirt roads) will be used to reach the unreeling positions.

The interim storage facilities, which will each cover several hectares located close to the SuedLink route, will conveniently supply the construction sites with the cables needed there. The ground will be specially reinforced to support the heavy goods vehicle traffic and the cable reels, which will weigh several tonnes. When selecting locations, TransnetBW and TenneT have given preference to industrial zones and business parks. This makes it possible to effectively use pre-existing infrastructure and minimise any additional impacts on the landscape.

Each of the eight storage facilities will supply construction sites within a radius of approximately 100 kilometres. This will allow the heavy-duty low-bed trucks to travel between the storage and construction sites in a single night. Office containers will accommodate the teams responsible for storing, transporting and laying the cables. Changing rooms, toilets and showers will be found in special containers. A security service will keep watch over the storage site around the clock.

Most work-related activities will be performed during the day. In order to keep any traffic disruptions to a minimum, the only activity to be performed at night will be transporting the cable reels to and from the sites. No transports are planned at the weekends.

Cable interim storage facilities will be spaced out at regular intervals along the SuedLink route



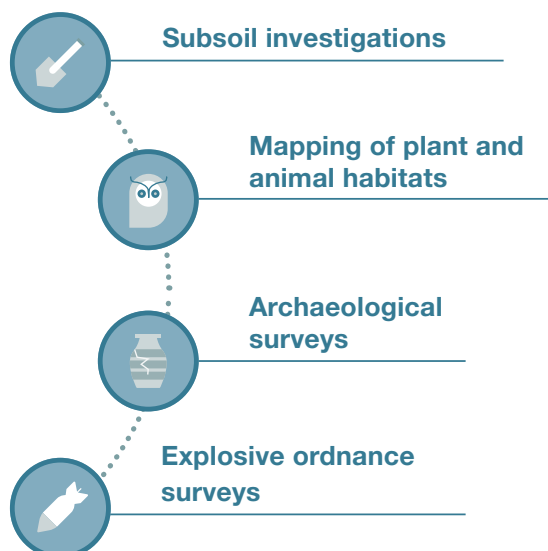
- 1 **Brunsbüttel:** Elbehafen | Space in the port as required in consultation with Brunsbüttel Ports GmbH
- 2 **Zeven:** Industrial zone Hochkamp Part II
- 3 **Berkhof:** Business park on the A7 federal motorway (autobahn)
- 4 **Hildesheim:** Lerchenkamp-Ost
- 5 **Philippsthal:** Business park on Industriestrasse
- 6 **Queienfeld:** Industrial zone Thüringer Tor
- 7 **Kitzingen:** conneKT Technologiepark Kitzingen
- 8 **Heilbronn:** Port



As part of the subsoil investigations, soil samples taken along the SuedLink route have been precisely analysed so as to tailor the transmission line's construction to local circumstances.

How SuedLink will be built

TransnetBW and TenneT are committed to minimising any impact on local residents, the surrounding environment and nature – before, during and after the construction of SuedLink. A range of pre-construction measures will help to make this possible. For example, areas affected by SuedLink are being surveyed to identify particularly valuable animal and plant species, soils worthy of protection, and cultural monuments. Other important measures in the pre-construction phase will include subsoil investigations, habitat mapping, explosive ordnance clearance and taking measurements. After that, construction roads and storage areas will be established.





Open laying method in the cable trench

If permitted by the conditions of the ground and if there are no obstacles, the open method of laying cables will be the standard technique used for SuedLink. With the open method, the underground cables are laid in pairs directly in an open cable trench.

The cables for Project 3 and Project 4 will each have their own trench, which will be around three metres wide at the bottom. The cables within a trench will have a maximum spacing of 1.9 metres and a minimum depth of 1.3 metres. Besides the power cables, the trenches will include five-centimetre-wide pipes to house fibre-optic cables as well as conductors to dissipate power surges in regions particularly vulnerable to lightning strikes.

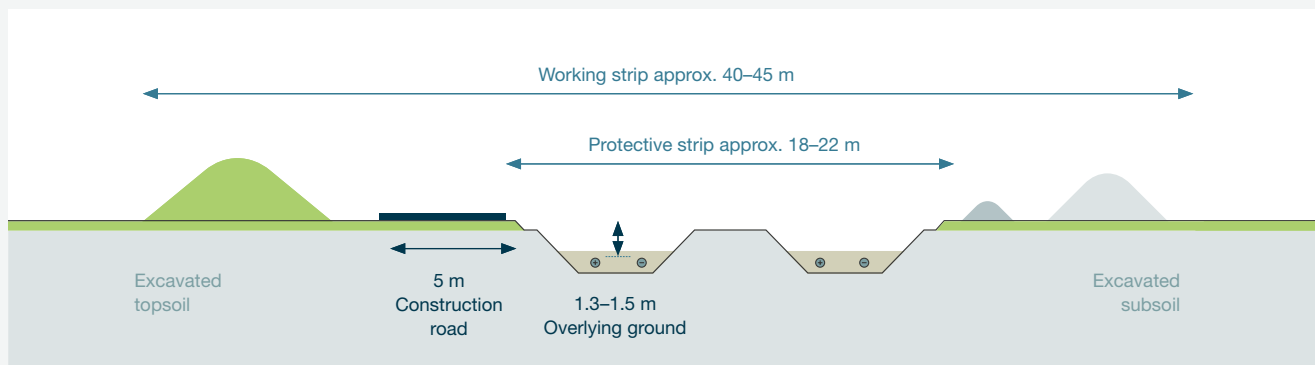
Along the combined section, both trenches will run parallel to each other at a distance of between five and eight metres. The two cable systems will only be laid separately as single sections at the northern and southern end points of the connections.

During the construction phase, space will be needed not only for the cable trenches, but also for construction vehicles and excavated soil. There, the various soil layers will be stored separately from each other so that they can be backfilled in layers once the cables have been laid. While the strip along the combined section will be roughly 40–45 metres wide, that along the single sections will be 30–35 metres wide (see graphic below). Later, once SuedLink is in operation, the protective strip will only stretch about three metres out from the sides of the power cables. It will be possible to replant the protective strip and use it for agricultural, but there cannot be any deep-rooted woody plants or structures.

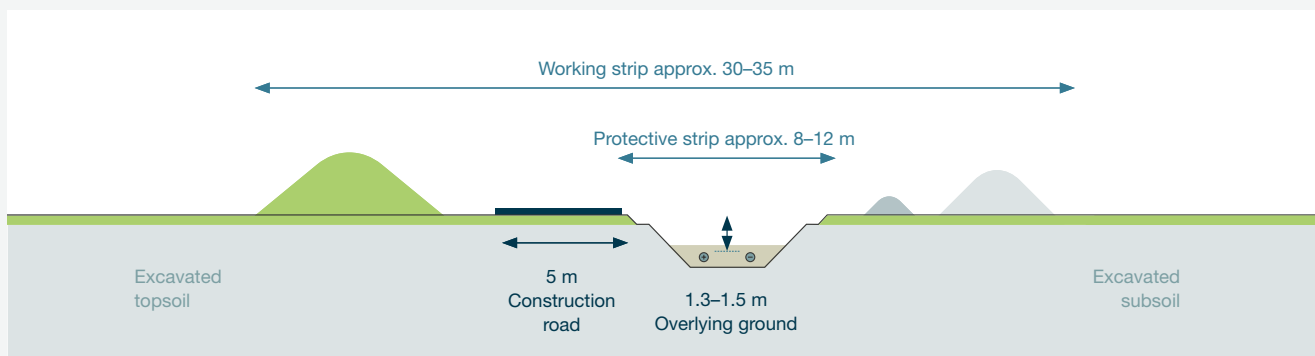
During the construction phase, it may be necessary to drain off water (so-called “dewatering”) to ensure safe operations. The drained water will be purified, if necessary, and usually discharged into suitable receiving waters. Receiving waters are surface waters into which rain-, waste- and other waters can be discharged. The construction phase will be followed by a recultivation phase.

A 45-metre-wide working strip will be required to build the combined sections of SuedLink. After construction, there will continue to be a 22-metre-wide protective strip, on which deep-rooted woody plants cannot be grown.

Standard cross section: Combined section 525 kV



Standard cross section: Simple section 525 kV



Standard cross sections of a combined section and a simple section



Construction periods for underground work and cable pulling

Rather than being systematically constructed from north to south, SuedLink will be built in individual sections. These segments, each stretching up to two kilometres long, will be completed in a gradual manner. Eventually, they will come together like a jigsaw puzzle to form the 700-kilometre-long transmission line.

12 Weeks

The construction firms commissioned by TransnetBW and TenneT will need about 12 weeks to complete the following steps for each segment:



Closed laying method

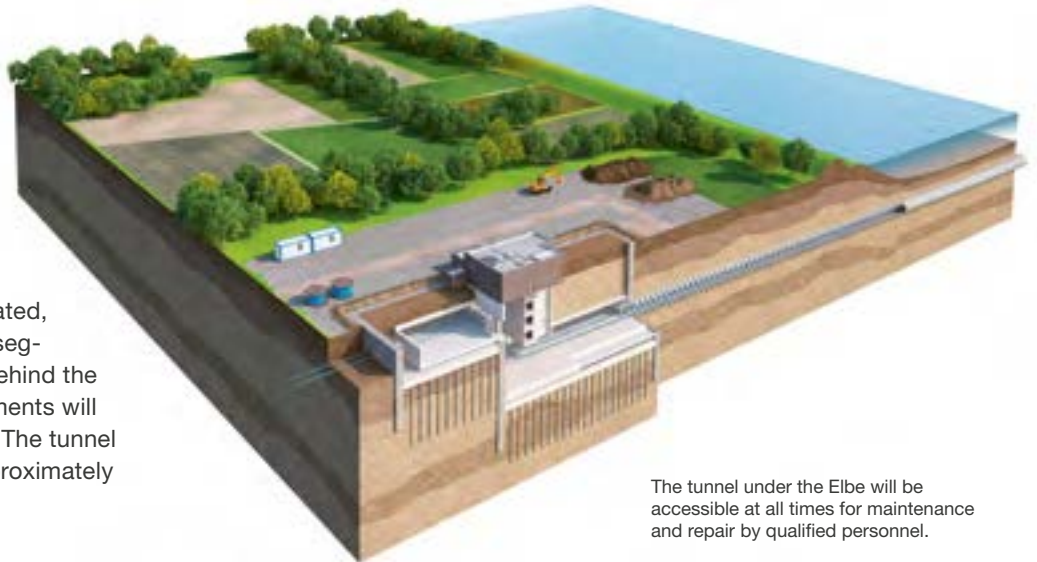
Where SuedLink intersects with obstacles (e.g. busy roads, bodies of water or railway lines), TransnetBW and TenneT will generally use closed construction methods. This technique makes it possible to pass under nature-conservation and forested areas. Various methods will be used, including horizontal directional drilling (HDD), controlled pipe jacking (pressing) and small boring machines (microtunnelling/E-Power Pipe).

With horizontal directional drilling, water bodies, roads and protected areas can be underpassed in an environmentally friendly way without having to dig a trench. Generally speaking, the HDD method is suitable for stretches up to 1,000 metres long. When bodies of water are smaller or only have intermittent flows, open-trench construction is usually also an option. With the closed laying method, the size of the area for the building site facilities will also depend on the length and depth of the borehole.

Due to the tensile forces acting on the cable, the maximum distance that can be underpassed will be 1,000 metres.

Special structures: The Elbe crossing (ElbX)

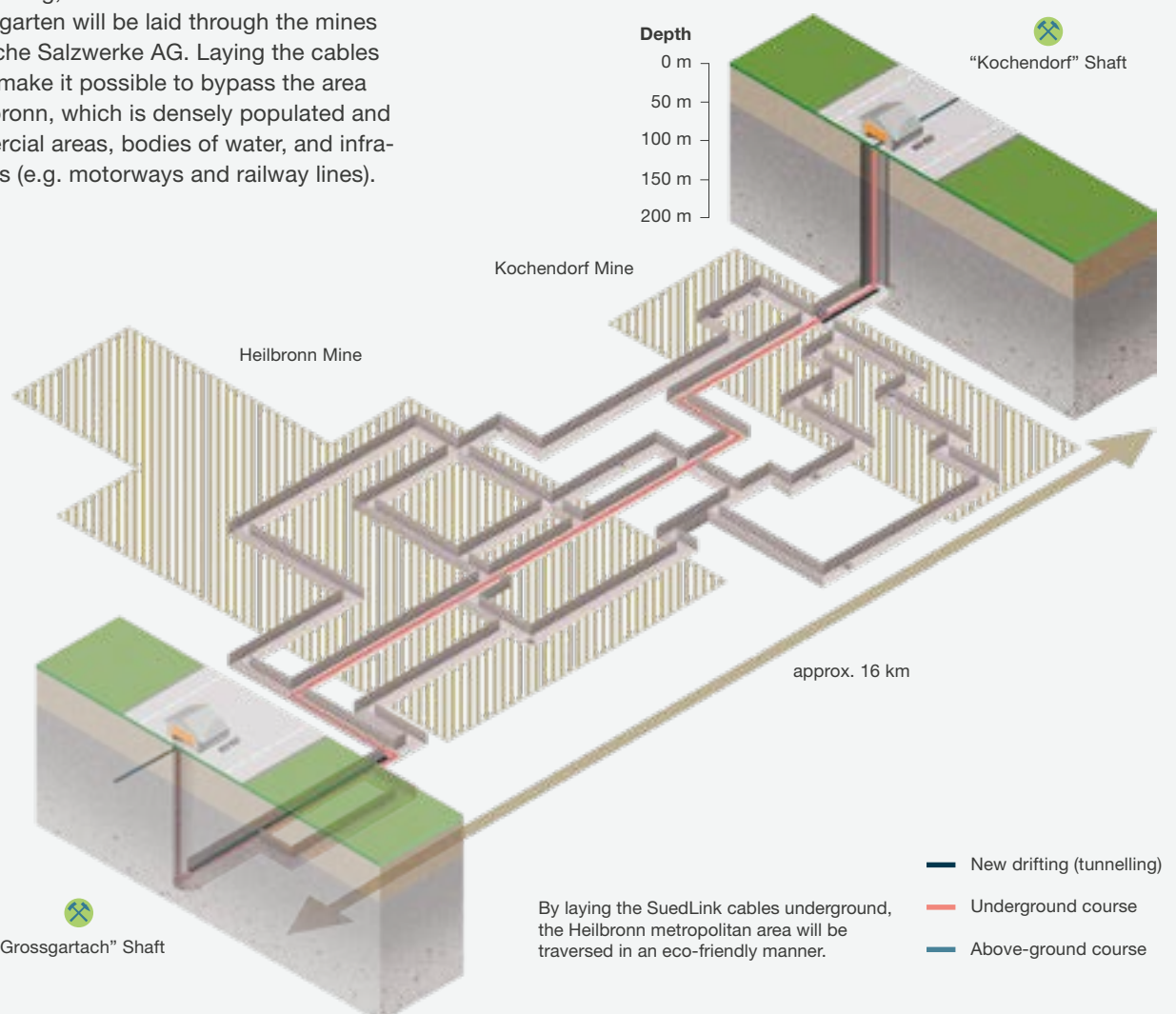
To cross the Elbe river, a roughly five-kilometre tunnel is being dug near Glückstadt, in Schleswig-Holstein. It will be accessible via two shafts. As the tunnel is being excavated, reinforced concrete rings ("tubbing segments") will be positioned directly behind the cutting wheel. Several of these segments will form a closed tube-shaped section. The tunnel will have an internal diameter of approximately four metres.



The tunnel under the Elbe will be accessible at all times for maintenance and repair by qualified personnel.

Salt mine

In Baden-Württemberg, the cables between Bad Friedrichshall and Leingarten will be laid through the mines of Südwestdeutsche Salzwerke AG. Laying the cables underground will make it possible to bypass the area surrounding Heilbronn, which is densely populated and has many commercial areas, bodies of water, and infrastructure elements (e.g. motorways and railway lines).



Careful Handling of the Soil as a Resource Worthy of Protection

During the construction and operation of SuedLink, areas used for agriculture and forestry are to be protected as much as possible. For this reason, comprehensive **pedological construction** supervision – meaning monitoring by soil specialists – will ensure the expert and careful handling of the soils right from the start. Trained soil scientists (e.g. geographers, agronomists and geo-ecologists) will make sure that the soil-protection requirements for SuedLink are complied with – during the planning, preliminary investigations, construction and recultivation.

The experts will assist the project developers in formulating and implementing **regionally specific soil-protection concepts**. Before construction begins, reference values for the condition of the soils will be recorded in order to be able to subsequently restore the natural functions and the yield capacity of the soil. The soil-protection concepts have been developed based on the “Guidelines for Soil Protection”, which were specifically developed for this project in consultation with government agencies, associations, farmers and local experts.

To identify any potential impacts on agricultural and forestry use as well as on special crops (e.g. wine grapes and fruit), both project developers are carefully investigating and assessing the impact of underground cables on the soil and water balance.



The responsibilities of the **pedological construction supervision** teams will mainly have to do with the soils that will be made available again for agricultural and forestry use or as a natural habitat. The aim is to preserve, safeguard and restore the natural functions of the soil. This also includes plots needed, for example, for storage areas, construction site equipment areas, working areas and access routes.

To protect the soil, they will be using:

- » soil-protection concepts,
- » field surveys,
- » subsoil investigations,
- » drainage concepts,
- » landscape management planning (determination of land use requirements),
- » expert hydrological assessments,
- » thermal calculations.



Heated pipes are being used to simulate a possible interaction between underground cables and agriculture.



In order to be able to investigate soils that are as representative as possible, all of the field investigations are being conducted in locations close to SuedLink's route.

TransnetBW and TenneT have commissioned investigations of the impact of underground cables on soils

TenneT already has extensive experience in laying and operating underground cables. In fact, over the last decade, TenneT has laid more than 1,000 kilometres of direct current (DC) cable in Germany alone. This valuable practical experience is being harnessed in the planning of SuedLink. But TransnetBW and TenneT are also taking things one step further. In order to investigate the interactions between 525-kilovolt direct current underground cables and agriculture as well as to validate practical knowledge that has already been gained, the two project developers have established a total of seven trial fields at various locations. The approach to this research, which is based on the latest scientific and technical findings, has

been designed by independent universities that are lending their scientific expertise to the field investigations. While TransnetBW's field investigations are being supported by the University of Hohenheim, those of TenneT are being assisted by a consortium led by the University of Erlangen-Nuremberg (FAU) in partnership with Leibniz University Hannover and Kiel University of Applied Sciences.

One of the goals of the field investigations is to observe how the soils recover their natural functions after the impacts arising from construction. Another is to investigate whether any impacts on the agricultural crops can be detected.



Drainage concepts will ensure uninterrupted drainage of agricultural land

Elaborate drainage concepts will ensure that agricultural land can be drained during the construction and operation of SuedLink and that drainage systems will remain functional over the long term. As part of these efforts, certified planning experts will work directly on site with land owners and managers to document the drainage systems already in place as well as the characteristics and special features of the plots of land. The data will be incorporated into the concept so that the drainage systems can be restored to their original states once the construction work has been completed.



Special crops will be bypassed as much as possible

Special crops, including wine grapes and fruit, have special requirements in terms of their location, such as specific climate or soil conditions. In addition, growing special crops is particularly time-, labour- and cost-intensive. This makes it even more important to safeguard the special crops already in place in the areas to be traversed by the SuedLink line and to keep their specific needs in mind. Input gathered from public consultations have helped the project developers to avoid existing special crops wherever possible or to underpass them at a depth sufficient to protect them.





Compensation for the use of and potential damage to land

For the impacted owners of property or holders of their usage rights, the construction of SuedLink will entail an encroachment on their land. As the project developers, TransnetBW and TenneT will have to secure the rights to use third-party land as well as to compensate their owners or the holders of their usage rights for any possible damage. The aim is to ensure that they do not experience any financial drawbacks or losses as a result of the transmission line's construction. In addition to compensating for the use of the land, harvest-related losses, damage to crops, and any consequential damages, the payments will also offset any cultivation-related difficulties arising from the project. Should there be any doubts regarding these matters, experts will be asked to assess the situations.



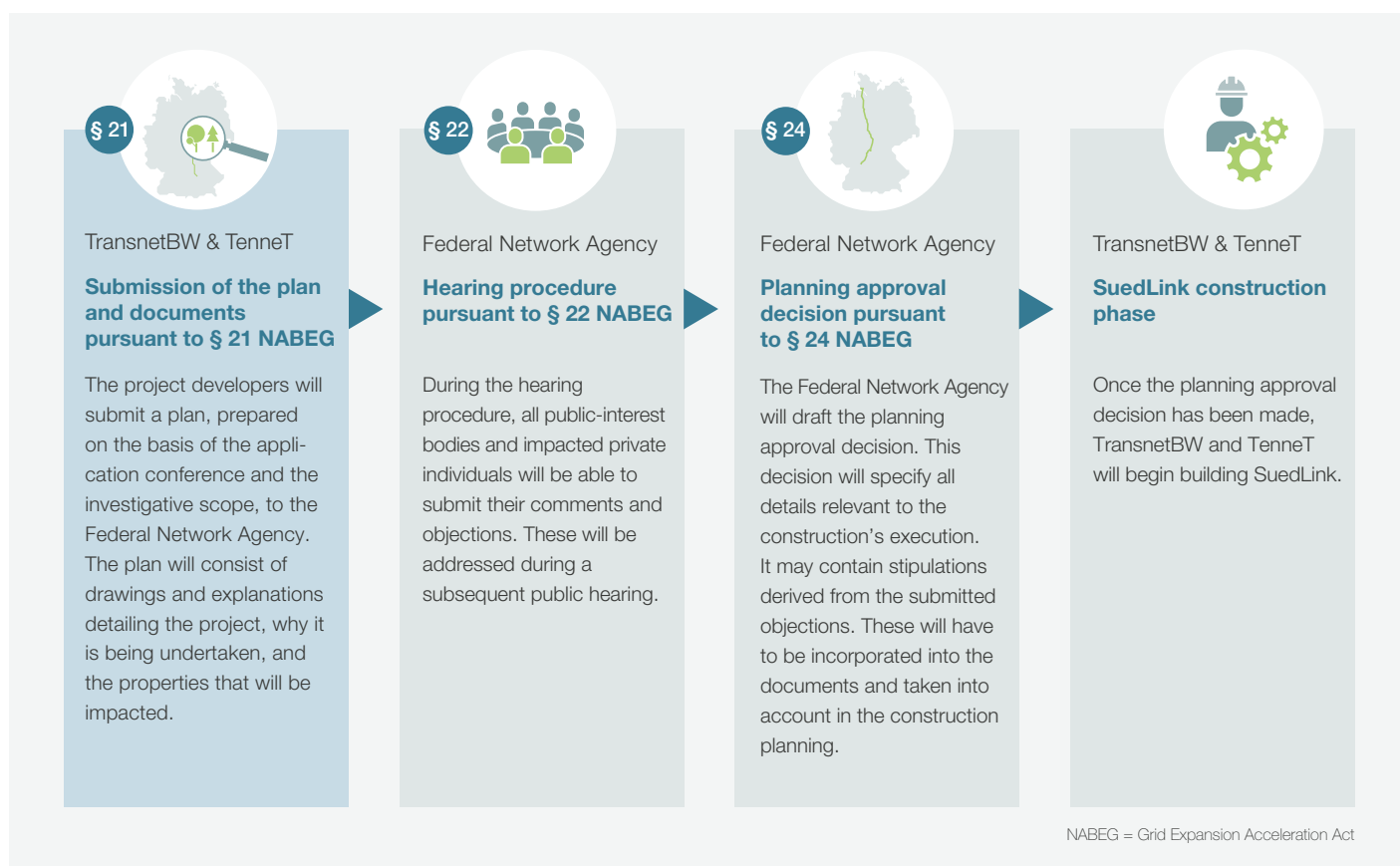
SuedLink will bypass or underpass special crops, such as those for wine grapes.

Looking Ahead – The Next Steps

On the path to building permits

Once all planning approval documents have been submitted, the Federal Network Agency will organise a hearing procedure. There, public-interest bodies (e.g. authorities, line operators and impacted parties) will be able to state their views, which they were required to submit in writing beforehand to the

Federal Network Agency within a public display period. After the hearing, the authority will weigh the objections against what is presented in the planning documents. At the end of this review, the Federal Network Agency will issue a planning approval decision – the permission to build SuedLink.



The planning approval documents and conditions for submitting comments can be found at www.netzausbau.de during the display and objection period (in German).



SuedLink will supply industry and households in southern Germany with renewable electricity beginning in 2028 – making Germany less dependent on fossil fuels.

How TransnetBW and TenneT plan to build SuedLink

The details regarding construction will not be part of the planning approval documents and will only be described in the execution plans once the planning approval decision has been made. For this purpose, separate sections will be formed within each of the 15 planning approval sections. The so-called lots (Lot 1, Lot 2 ...) will form the basis for the awarding of contracts to construction companies and for the subdivision into construction phases.

The construction plans will be drawn up on the basis of the planning approval decision and include all aspects involved in building SuedLink.

Among other things, these will include:

- » logistics for line construction, cables and construction sites
- » intersection planning with other infrastructures (e.g. roads, railways and utility lines),
- » soil-protection and drainage planning,
- » execution planning for landscape management measures in compensation areas.

Soil specialists present during the construction efforts will plan and monitor all soil-protections measures and the subsequent land restoration measures involving soil.

SuedLink will start transporting electricity in 2028

Since May 2022, TransnetBW and TenneT have been submitting planning approval documents for the individual segments of SuedLink to the Federal Network Agency. The two project developers have started with the two segments that are particularly demanding in engineering terms: the A2 segment of TenneT (Elbe crossing in Schleswig-Holstein and Lower Saxony) and the E3 segment of TransnetBW (which passes through the mines of Südwestdeutsche Salzwärke AG in Baden-Württemberg). Tunnelling the cables under the Elbe and laying them in the mine will each require a construction period of roughly five years. TransnetBW and TenneT are also planning a construction

phase of several years for the converters in Schleswig-Holstein, Bavaria and Baden-Württemberg.

Overall, several different specialised disciplines will be involved in building SuedLink, and its construction, logistics and commissioning will all be demanding. TransnetBW and TenneT aim to have SuedLink transmitting wind power from northern to southern Germany by the end of 2028. Though ambitious, this timetable is also realistic. And both project developers will be working hard in the years ahead to keep to it.



Glossary

Federal Requirements Plan Act (BBPIG)

The Federal Requirements Plan Act lists all the grid-expansion projects that will be needed over the next three years to ensure that Germany's electricity grid operates in a safe and reliable manner. Being listed means that a project has been deemed urgently needed for the energy system. SuedLink is listed as Project 3 and Project 4 in the BBPIG, which is passed by the Bundestag.

Federal Network Agency (BNetzA)

The Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway is the regulatory authority in Germany responsible for ensuring effective competition in the aforementioned sectors as well as non-discriminatory network access for all market participants. It safeguards important consumer rights and is also responsible for the implementation of the Grid Expansion Acceleration Act (NABEG).

Renewable Energies

The umbrella term "renewable energies" covers all energy carriers and sources that are continuously renewed or renewable. Renewable energies thus include solar energy, biomass, hydropower, wind energy, geothermal energy and tidal energy. To ensure that renewable resources are used sustainably, the rate of consumption must not be allowed to exceed the rate of production.

Grid Expansion Acceleration Act (NABEG)

Germany's Grid Expansion Acceleration Act aims to accelerate the expansion of transnational and cross-border high-voltage power lines as required by the Energy Industry Act. In addition, the Act lays the foundation for a legally secure, transparent, efficient and environmentally compatible expansion and strengthening of the country's transmission grid.

Grid Development Plan (NEP)

The grid development plan is part of a three-stage process that will be used to determine the need to expand and modify Germany's grid as required by the Energy Industry Act. Since 2011, the NDP has been prepared by the four transmission system operators in Germany, who specify what will be needed to modify and expand the high-voltage grid. Following public consultations, the NDP is approved by the Federal Network Agency before the Bundestag incorporates the endorsed grid expansion projects into the Federal Requirements Plan.

Germany's Power Grid

Germany's electricity grid is divided into ultra-high-, high-, medium- and low-voltage grids. The ultra-high-voltage grid (or "transmission grid") is used for the supra-regional transport of electricity and transmits voltages between 220 and 525 kilovolts. Ultra-high voltage lines connect densely populated areas and large industrial plants with power stations and large wind farms. Electricity is also exchanged among different countries via the ultra-high voltage grid. High-voltage lines (60–220 kilovolts) transmit the electricity to local power suppliers. Regional distribution networks at the low- and medium-voltage levels (230–400 volts and 6–60 kilovolts, respectively) then forward the electricity to households and industry.

Public-Interest Bodies

Public-interest bodies are authorities and agencies that are to comment on building projects from the perspective of their area of responsibility. These include (specialised) agencies at the municipal, district, state and federal levels. Water supply companies, transport companies and the German armed forces can also be public-interest bodies.

Transmission System Operator (TSO)

Transmission system operators are service companies that operate the infrastructure of the supra-regional electricity grids for the transmission of electrical energy, ensure that they are maintained and scaled to meet demand, and grant electricity traders and suppliers access to these grids on a non-discriminatory basis.

Alternating and Direct Current

With alternating current (AC), the current alternates back and forth between the positive and negative pole. The current reaches both the negative and positive pole 50 times a second, giving it a frequency of 50 hertz. With direct current (DC), the current does not change its polarity, meaning that there is no switching between positive and negative poles on a cable. Instead, one cable at a time constantly serves as the positive or negative pole.



Additional Information

More information on SuedLink (e.g. on construction logistics, indemnification practices or pre-construction measures) as well as all brochures can be found on the project developers' websites (in German):



suedlink.com



suedlink.tennet.eu

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TenneT is responsible for the northern section of the SuedLink route as well as the converters in Schleswig-Holstein and Bavaria. TransnetBW is responsible for the southern section of the route and the converter in Baden-Württemberg. More at **suedlink.tennet.eu** and **suedlink.com**.



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The content reflects the opinion of the project developers
and not that of the European Commission.