ALEGRO

THE FIRST POWER BRIDGE TO BELGIUM

amprion

THE AMPRION GRID

Amprion's transmission grid has a length of about 11,000 kilometres and is the longest ultra-high-voltage network in Germany. Our grid provides more than 27 million people with a reliable electricity supply, day in, day out, from Lower Saxony to the Alps.


Overhead line
Substation
Lower Saxony
Netherlands
North Rhine-Westphalia
DORTMUND
COLOGNE
Hesse
Thuringia
Belgium
FRANKFURT AM MAIN
Bavaria
Luxembourg
Rhineland Palatinate
Saarland
SAARBRÜCKEN
Baden-Wuerttemberg
STUTTGART
France
AUGSBURG
Switzerland
Austria

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ALEGrO – the first power bridge between Germany and Belgium. This 100-kilometre-long connection can transmit about 1,000 megawatts of power. Here at Amprion, we are planning and constructing ALEGrO together with our Belgian partner Elia. The project draws on innovative technology: direct current transmission at a voltage level of 320 kilovolts. ALEGrO is scheduled for completion in 2019 – and will make the European electricity network even more secure and powerful.

'We listen to you'

INGO SANDER, ALEGRO PROJECT MANAGER, AND JOËLLE BOUILLON (PRESS RELATIONS) TALK ABOUT HOW THEY INTEND TO INVOLVE LOCAL RESIDENTS IN THE PROJECT.

WHY IS IT IMPORTANT FOR AMPRION TO INFORM LOCAL RESIDENTS ABOUT ALEGRO AT AN EARLY STAGE?

IS You have to bear in mind that the region is characterised by other infrastructures, such as opencast mines and power stations. And the people themselves have very different interests. A lot of people see the cable as the better alternative because it is not a visible feature in the landscape. But the farmers see it totally differently – for them, it is a major incursion.

HOW DO YOU PLAN TO APPROACH THE LOCAL RESIDENTS?

JB Our information forums are intended not only to provide information but also to give us an opportunity to listen, to enable us to take the wishes and comments of the local residents into account in our plans before the actual approval process starts. That will save us time. We also want to and must be honest, however. We will spell out clearly where we have only limited room for manoeuvre for technical reasons.

HOW DO YOU INTEND TO KEEP THE RESIDENTS INVOLVED BEYOND THE INFORMATION FORUMS?

JB We have created an online participation platform, the first for a line construction project in Germany. This gives the residents a direct and uncomplicated channel to share their suggestions with us.

WHAT IS THE CURRENT STATUS OF ALEGRO?

IS The talks in 2013 related mainly to the converter, in other words, the system at the point where the cable starts in Oberzier. Since then we have refined the preliminary plans for various route corridors. We have reached the point where we can present a draft route and discuss it with the local residents.

JB ... And we want to be quite specific: this is the route we are talking about, we have already reviewed many arguments and alternatives and in some places we can see no other options – but we are not perfect, either. If our talks with local residents bring up further improvements to the cable route, we still have the opportunity to include these in the planning documents.

JOËLLE BOUILLON (left) is responsible for communications regarding the high-voltage direct current projects. With qualifications in communications and political sciences, she is working with Ingo Sander to plan the information campaign and civic participation for ALEGrO.

INGO SANDER (right) is an engineer and expert in asset management. He has headed the ALEGrO project since mid 2012.

CONTACTS AND FURTHER INFORMATION

YOUR CONTACTS AT AMPRION

Joëlle Bouillon

Corporate Communication
Tel.: +49 (0)231 5849–12932

Amprion GmbH
Rheinlanddamm 24
44139 Dortmund

ALEGrO

Email: alegro@amprion.net
www.amprion.net/en/

Free information hotline:
+49 (0)800–58952474

Participation platform:
alegrodialog.de/content/information-english

APPROVAL AUTHORITIES

Cologne Regional Government
www.bezreg-koeln.nrw.de

INFORMATION OFFICES

German Federal Network Agency, Bonn
www.netzausbau.de/en

Grid Development Plan, Electricity
www.netzentwicklungsplan.de/en

European Commission (PCI)
www.ec.europa.eu/energy/infrastructure

The changing face of electricity networks

For many people, electricity is simply what comes out of the socket. Where it has been on the way there doesn't interest them, as long as it is there when they flip the switch. As transmission system operators, we think that's how it should be. It means we are doing our job – transporting electricity – properly. Now, however, we face the task of explaining to our customers why we have to modify the electricity network. The new overhead lines, **substations** and converter stations were at first met with a lack of understanding in many quarters. p. 23

Most power stations in Germany and elsewhere in Europe have previously been constructed close to cities or industrial areas. That meant that electricity never had to be transported very far. It stayed in the local area. But the energy providers then linked up their electricity networks. That meant they could offset local fluctuations or bring in electricity in the event of an emergency. Now, electricity networks are linked across Europe and use the same frequency everywhere. For a few years, however, we have observed three important developments that will totally change the world of electricity:

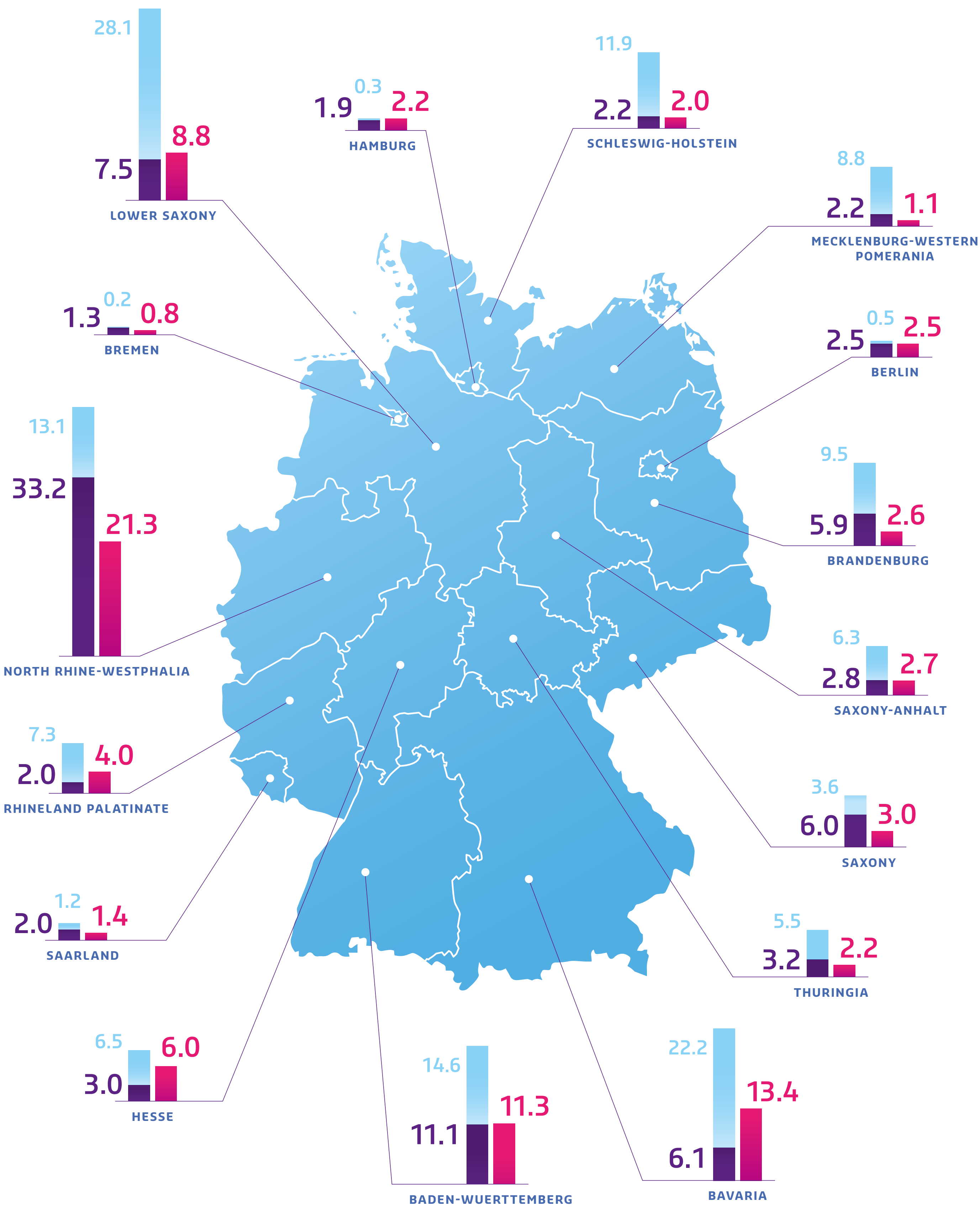
- More and more plants are generating electricity where it is not consumed.
- More and more electricity is being traded throughout Europe.
- More and more wind and photovoltaic plants are feeding electricity into the grid.

Power stations and electricity networks no longer fit perfectly together

Many power stations are now so old that they need to be decommissioned and replaced with new ones. Germany has also decided to abandon its nuclear energy programme. The power stations and transmission networks originally belonged to major energy providers, which kept the two coordinated. This was changed by the European Union in 1998; now there are power station operators and network operators. And that is where the challenge lies: the new power station operators plan their power stations where they can acquire their fuels (coal or gas) cheaply, or where the wind blows or the sun shines. For us as transmission system operators, this means we sometimes have to take new electricity connections out to these power stations and then transport the electricity across quite sizeable distances to the customers. There has also been a substantial increase in electricity trading in Europe since 1998. And that means there is more electricity that has to be transported.

But the biggest change is being caused by converting electricity generation systems to renewable energy. While this development is positive for the climate, it creates two major challenges for us.

ELECTRICITY LANDSCAPE, 2023



Installed assured capacity from conventional electricity generation in gigawatts (GW): Lignite, hard coal, natural gas, oil, pumped storage, other conventional energy sources

Installed weather-dependent capacity from renewable electricity generation in gigawatts (GW): Onshore wind, offshore wind, photovoltaics, biomass, hydroelectricity, other renewable energy sources

Maximum consumption capacity for each federal state in gigawatts (GW)

Source: Grid Development Plan 2013, Scenario B 2023

Now, wind turbines along the coast and in the North Sea and the Baltic are generating increasing amounts of electricity. Powerful solar farms can be found in southern Germany in particular (see pale blue bar in the graphic on page 5). With the nuclear power stations being decommissioned, however, it is mainly in that region where the bulk of the assured conventional power generation will be lost (see purple bar on page 5). To prevent supply bottlenecks from occurring in the south, we need to direct electricity there from the northern and eastern parts of the country.

This trend will only be exacerbated in the future. Although there are many projects seeking to achieve a decentralised electricity supply – energy villages, for example – we are certain that industry and major cities will consume much more electricity than it is possible to generate locally.

Wind turbines and photovoltaics, however, supply electricity only when the weather conditions are right – in other words, not precisely when people need it. For us, that means even more electricity transport across large distances, which is also difficult to plan. Whenever the wind suddenly loses strength in a given location, or if a cloud passes in front of the sun, we need to source electricity from somewhere else via our grid in double quick time.

But that was not what the German electricity network was designed for. It is still coping with the additional load, but will soon reach its limits. To prevent that from happening, we need to expand and strengthen the existing network – 'we' being not just Amprion but all transmission system operators throughout Europe.

2050

IS THE TARGET YEAR

for the German government's energy strategy, which is planning a step-by-step expansion of renewables.

80

PER CENT

is the target for the proportion of Germany's electricity generation to be covered by renewables in 2050.

The tasks for Amprion

The electricity network is built on similar principles to the road network: there are routes for long-distance transport (the transmission grid) and routes for local transport (the distribution system). Since 1998 this grid has been split along organisational lines: the distribution system in Germany belongs to about 800 companies – municipal utilities, for example. The electricity 'motorways', on the other hand, belong to the four transmission system operators, one of which is Amprion.

An electricity network needs balance

Operating an electricity network is labour-intensive and demanding. The challenge is to keep generation and consumption in permanent balance: the electricity that is supplied must match the volume consumed at every moment of the day. If we fail to maintain this balance, the result is an electricity outage. Our task is to prevent that from happening.

In our day-to-day business our first concern is to ensure that the timetables for the power stations are correct. Conventional power stations generate electricity based on a plan; wind turbines and solar cells have forecasts. Power station operators negotiate with their customers to establish how much power they will supply, and when. Whether this electricity transaction is technically feasible is something that we check one day in advance.

Balancing second by second

If the timetable then comes into force, our system operation experts in Brauweiler monitor it to ensure it is observed. That means checking whether the energy that is delivered matches the amount being drawn off – every second. They have to respond to any deviations swiftly: if too little electricity is fed into the grid, reserve capacities are activated, whereas if too much is supplied, power stations are cut off from the grid.

The supreme achievement in our system management is to integrate wind and solar power stations into this process. In any case, Amprion is already responsible for marketing for 34 percent of Germany's solar and wind power stations. Our engineers are now able to balance out the weather-based fluctuations in generation quickly and reliably, because our grid has been well structured to allow electricity to be procured or forwarded via many different routes. Things will look different in future, however.

2,300 KM

OF POWER LINES

To be strengthened or built from new by Amprion. We will invest a total of more than €5 billion in our network by 2023.

AMPRION POWER LINE PROJECTS

Power line projects under the German Energy Line Expansion Act (EnLAG no.)

- 2 Ganderkesee › Wehrendorf
- 5 Diele › Niederrhein
- 7 Bergkamen › Gersteinwerk
- 8 Kriftel › Eschborn
- 13 Wesel › Doetinchem
- 14 Niederrhein › Osterath
- 15 Osterath › Weissenthurm
- 16 Wehrendorf › Gütersloh
- 17 Gütersloh › Bechterdissen
- 18 Lüstringen › Westerkappeln
- 19 Kruckel › Dauersberg
- 20 Dauersberg › Hünfelden
- 21 Marxheim › Kelsterbach

Proposed power line projects under the German Federal Requirement – Plan Act (BBPlg no.)

- 1 Emden / Borssum › Osterath
- 2 Osterath › Philippsburg (Ultranet)
- 5 Lauchstädt › Meitingen
- 9 Hamm / Uentrop › Kruckel
- 15 Metternich › Niederstedem
- 16 Kriftel › Obererlenbach
- 19 Urberach › Daxlanden
- 23 Herbertingen › Tiengen
- 24 Rommelsbach › Herbertingen
- 25 Wullenstetten › Niederwangen
- 30 Oberzier › Belgian border (ALEGrO)
- 36 Vöhringen › Austrian border

Maintaining a balance is becoming harder

The German government has a clear objective: by 2025, wind and solar power must supply 40 to 45 percent of the country's electricity on average over the year – almost twice today's figure. This means that in future fluctuations in the supply of electricity from deliverables will require much larger volumes of energy to be transmitted through the grid to restore the balance.

We need to prepare the grid for these new flows of electricity, while keeping the number of lines to be expanded or installed to a minimum. How this new grid landscape will look has been a focus for all transmission system operators, p. 22 / 23 together with the **German Federal Network Agency**, since 2012. The results are flowing into the **Grid Development Plan.** The projects included in this list, which are essential for maintaining a secure supply of electricity, will be set in p. 22 the **Federal Requirement Plan Act** every three years. The first came into force on 27 July 2013.

For Amprion, this means that we will need a total of 2,300 kilometres of new lines – most where transmission routes are already in place. For 770 kilometres of this total, however, we will have to install completely new lines. We will invest a total of more than €5 billion in our network by 2023.

AMPRION – YESTERDAY AND TODAY

Amprion has its origins in the RWE Group and has a lengthy tradition behind it: in 1929 the company established Europe's first 220 kilovolt ultra-high voltage line and was a partner in the first interconnected system. In 2003, RWE hived off its network division and sold the majority to an infrastructure fund in 2011. Currently, insurance companies and pension funds hold 74.9 percent and RWE 25.1 percent of Amprion. Over 1,000 employees operate and maintain the Amprion network, which spans about 11,000 kilometres in total, plan and implement the network expansion, provide support for electricity trading and balance out the electricity supplied. From our system operation and control in Brauweiler, we not only control our grid but also coordinate the flow of electricity between the German transmission system operators and those in central and eastern Europe.

One cable – many goals

A key project that we want to implement together with Belgian transmission system operator Elia is known as ALEGrO, which stands for Aachen-Liege Electricity **Grid Overlay**. ALEGrO is a high-voltage DC cable between the Oberzier **substation** in the Rhineland and Lixhe in Belgium. The first direct electricity connection between Belgium and Germany, it is split almost evenly between the two countries; each company finances the construction work in its own territory.

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Electricity markets grow closer together

The EU opened the way to electricity trading throughout Europe in 1998. One consequence of this trade, however, is additional electrical current flows through Belgium and the Netherlands. As a result – and this is still the case today, at least in part – Elia's transmission grid was no longer fully available to transport electricity in its own country.

One element in resolving this problem is a high-voltage direct-current transmission cable, or HVDC cable for short. While this technology is still relatively new, it has proved itself in international projects. Regardless of the prevailing flow of electricity, this HVDC cable can supply up to 1,000 megawatts to either Belgium or Germany – about the same as the amount generated by a reactor unit in Tihange. The technicians can also precisely adjust the volume of electricity and flow direction, which means that undesired additional volumes of electricity from international electricity trading in Belgium (as in the Netherlands and Germany) can be diverted, at least in part, which takes the load off the Elia grid. And because this all happens at high speed, the Belgian system management team in Brussels can also use the cable to balance the fluctuating volumes of electricity generated from renewables.

What is the benefit for Germany?

The first power bridge between Germany and Belgium will benefit Amprion and German consumers in equal measure:

- ALEGrO helps us better balance out wind energy feed-in between Germany and Belgium.
- Because we can control the cable with a high degree of accuracy, this substantially improves the security of supply in the Aachen–Cologne area.
- ALEGrO contributes greatly toward helping the European energy markets grow closer together.

All of these benefits underlie our desire to construct this cable. And because ALEGrO will benefit electricity customers in Belgium, the Netherlands, France and Germany, the EU is sponsoring it as a Project of Common Interest (**PCI**).

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ROUTE FOLLOWED BY ALEGRO

The German–Belgian power bridge covers a distance of some 100 kilometres between Oberzier and Lixhe.

1,000

MEGAWATTS

is the volume of energy that ALEGrO can transmit. This is enough to supply about one million people.

Technology

The fact that the cable uses a direct current rather than alternating current is what makes the benefits of ALEGrO possible. There are two types of electricity: if the voltage and current are constant, this is known as 'direct current' (DC); but if its polarity is changed at regular intervals, this is known as 'alternating current' (AC).

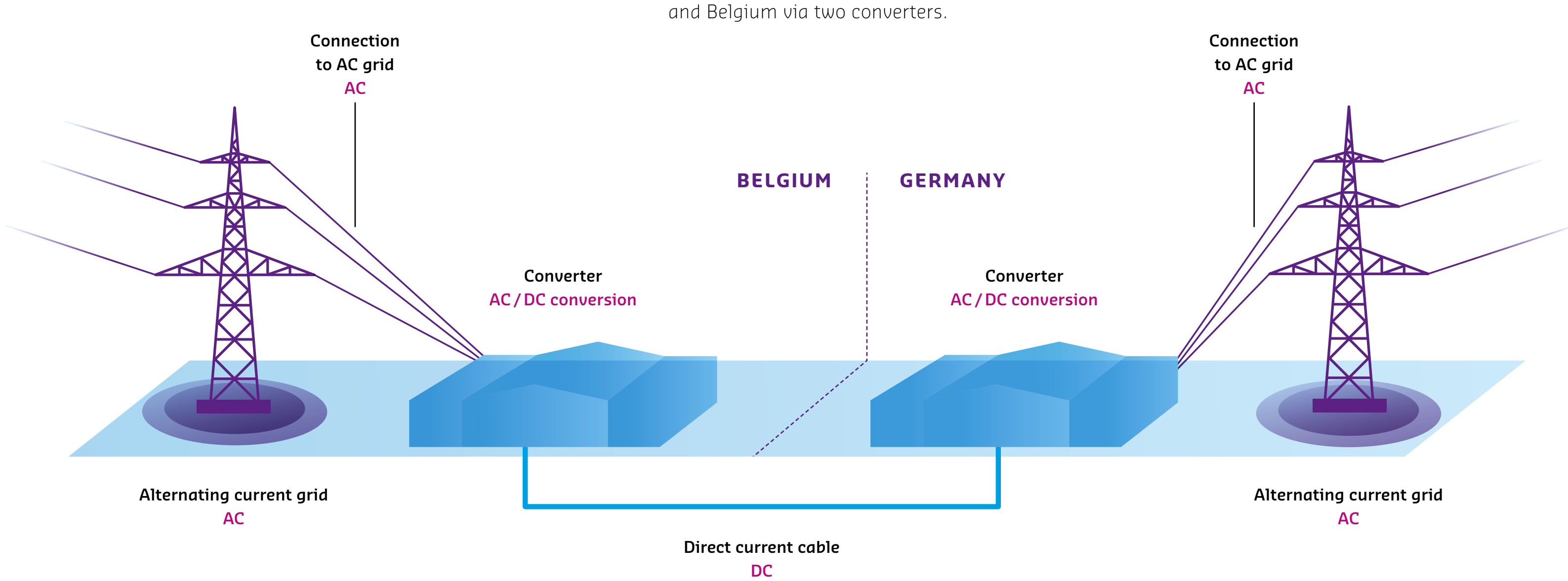
Both types of electricity offer advantages and disadvantages for transmission system operators: direct current is handy when large volumes of power have to be transported over long distances. This is based on the fact that less energy is lost through heating the conductors when large volumes of electricity are fed through a DC cable compared to alternating current. Alternating current is better suited to electricity networks, however, because the voltage level can be adjusted and the electricity fed into the downstream networks much more easily and efficiently. This is why network operators usually use high-voltage AC for electricity transfers.

Direct current requires converters

Both types of electricity are in daily use: sockets supply alternating current, and refrigerators and vacuum cleaners use it. But smartphones, LCD TVs, LEDs or tablets – essentially everything that contains electronic components or

HOW ALEGRO WORKS

Ultra-high voltage below ground: the underground DC cable is connected to the AC networks in Germany and Belgium via two converters.



batteries – uses direct current. And because the grid supplies alternating current, these devices require their own power supply. These take the form of small 'converters' with a voltage transformer and rectifier to convert AC into DC.

These are the very elements that ALEGrO also needs – only the voltages and currents are much higher: in this case, the converters are connected directly to the 380 kilovolt AC grid. The converter converts this voltage into 320 kilovolt. This enables up to 1,000 megawatts to be transferred, which equates to the capacity of a major power station.

The converter – the heart of ALEGrO

The heart of ALEGrO is the converter. It consists of transistors, diodes, condensers and coils – the same components that are found in a much smaller format in the power supplies. Where large capacities are involved, these parts have to be much more bulky. Because they, and the associated control electronics, have to be protected against wind and weather influences, this switchgear is accommodated in its own building.

Direct current flows on one side of the converter building, and alternating current on the other. On the AC side, transformers take care of the adjustment to the 380-kilovolt grid. ALEGrO will use what is currently the latest converter technology, the Modular Multilevel Converter or MMC. On the one hand, this permits a comparatively compact structure to be achieved. On the other, it offers benefits for the electricity network. The grid operator can precisely set how much power must be transferred, and in which direction – whether from Oberzier to Lixhe or vice versa. With a direct-current grid, this could not be achieved so readily since DC current always seeks the path of least resistance.

Regardless of the power being transferred, each converter station can also be used to help stabilise the voltage in the AC grid. Before the voltage becomes too high or too low, the converter can take counteracting measures at lightning p. 23 speed. These days, this is mainly done using power station generators. Engineers refer to supplying **reactive power** in this connection. The converter is able to react to voltage fluctuations in less than a thousandth of a second. If, for instance, a lightning strike during a storm causes a short circuit in a 380-kilovolt cable, the converter helps to stabilise the electricity network. The converter can also help to achieve a balance when there are fluctuations in the feed-in from wind and solar power stations.

The ALEGrO cables

We picked Oberzier as the place to connect the ALEGrO converter because that's where many high-voltage lines come together. This location ensures that there is always enough energy available for transportation to Belgium or for distribution after coming from Belgium. There will be very little of the actual power line to be seen: the two 12-centimetre-thick cables – one positive pole and one negative pole – run underground to the Belgian border and on to the other converter. This means the line will not disturb the landscape and will cause as little disruption as possible for the local residents.

People and the environment

We are designing ALEGrO to keep the burdens on both people and the environment to a minimum, both during construction and once it is in operation.

Construction sites

To implement ALEGrO, we will set up two construction sites: one at the transformer substation, where the converter station will take shape after about two years of building work. During this period, goods vehicles and the occasional heavy transport vehicle will travel to the construction site with construction materials, take earth away and deliver items such as transformers. We would like the construction and transportation processes to cause as little disruption as possible. The second will be a mobile work zone where workers will excavate a trench in which both of the cables, the earthing system and a data cable will be laid.

Construction that's gentle on the ground

We will be as gentle on the ground as we can when we lay the cables. Third-party experts will examine the ground before the work begins and will establish aspects such as what layers of earth are present and how to handle them.

During the construction work, the excavators will remove the ground in short sections, layer by layer, and place it in the correct order next to the trench. At a depth of about two metres, workers will lay two empty pipes for the cables, which will be subsequently inserted step by step, and the excavators will then fill in the trenches again. This involves carefully returning the various layers of earth that had previously been stacked, which keeps the structure of the soil largely intact, enabling it to regenerate more quickly.

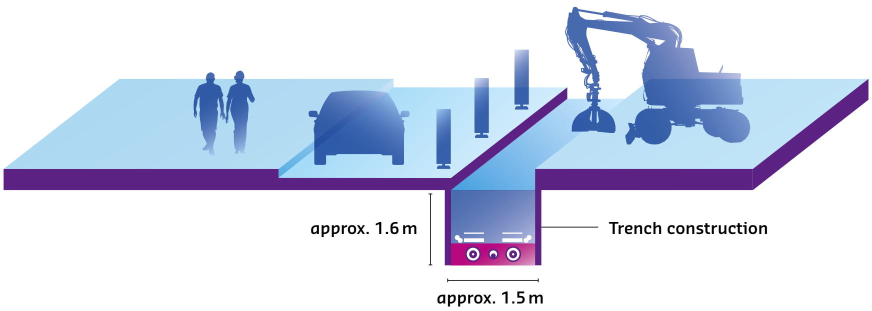
Protective strips

We want to construct the converter station to ensure that as little as possible can be seen from neighbouring locations. No part of the cables will be seen, either. Above the cable trench, in the vicinity of the 'protective strip', animals will be able to continue grazing and fields can be cultivated. Two things will not be permitted, however: no houses can be built on the protective strip, and woods or plants with deep roots cannot be planted. This restriction is necessary to ensure that the cables are not damaged by the roots and also to enable our employees to access problem areas quickly in an emergency. The width of the protective strip will depend on the local circumstances.

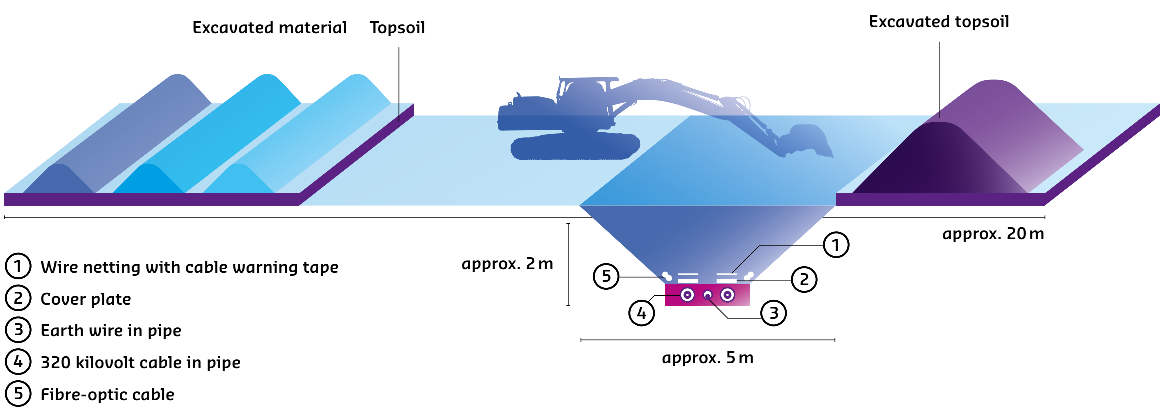
LAYING UNDERGROUND CABLES

If the underground cable is laid in areas that are not built on, the mobile work zone requires a width of about 20 metres. If the cable runs under roads, only one side of the road needs to be closed.

LAYING CABLES BELOW ROADS
(ROAD CLOSURE: ONE SIDE ONLY)

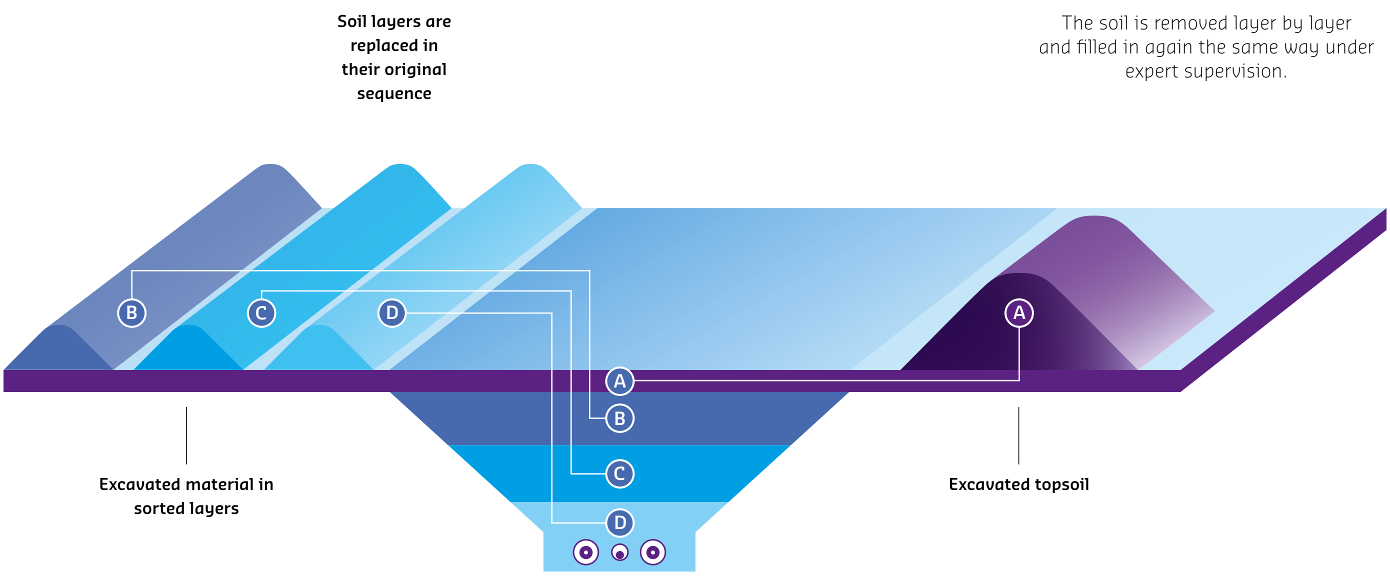


LAYING CABLES IN OPEN/ AGRICULTURAL AREAS



SOIL STRUCTURE IS KEPT INTACT

The soil is removed layer by layer and filled in again the same way under expert supervision.

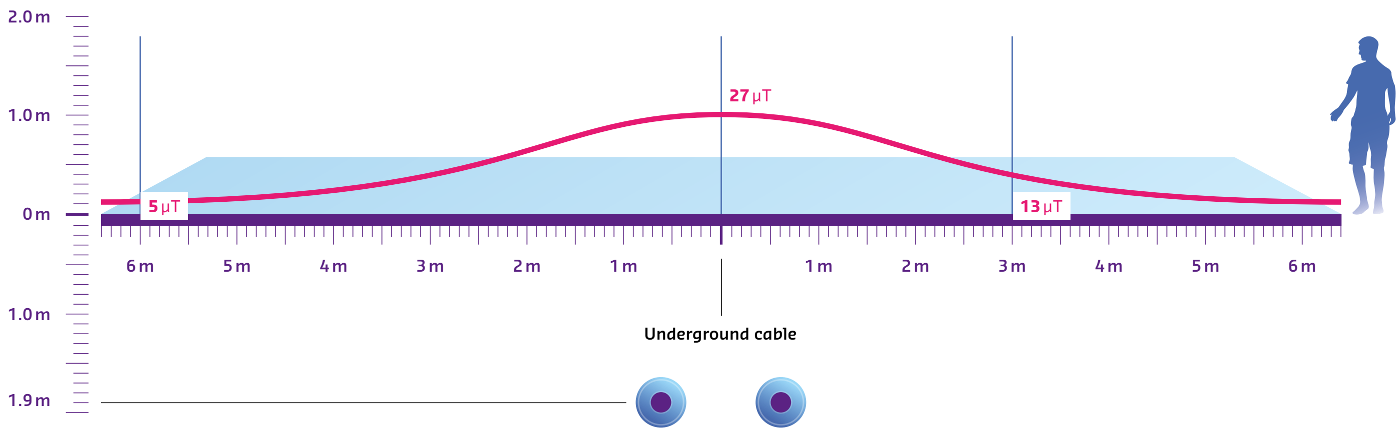


Cable heating

Heat is generated wherever electricity flows. This also happens with underground cables. How hot the two ALEGrO cables will become in operation depends on factors such as the load factor and the way the cables are laid, as well as other technical parameters. With cables, the highest temperature is always generated in the conductor. Studies have shown that temperature fluctuations based on the season and weather conditions (e. g. winter or summer or direct sunlight) in the upper levels of the soil are much greater than the influences of a cable itself in the form that we intend to use for ALEGrO. In addition, as far as we are currently aware, there will be no restrictions on agricultural use of the land above the cable.

MAGNETIC FIELDS

With the cable load factor at a maximum and at a height of one metre, the magnetic field will be no more than 27 microteslas.



Electromagnetic fields

p. 22 **Fields** are generated wherever electricity flows – both electrical and magnetic. This is something that cannot be avoided. It is easy to shield the electrical field, however, making it undetectable beyond the converter station and along the cable route itself. With the converter, the construction materials used in the building shield the electromagnetic field, while the metal sheathing performs this task for the cables.

The magnetic field, on the other hand, is not so easy to screen off. Direct current does not create a pulsating magnetic field but a constant one – the same as the earth's natural magnetic field, which is in the range of 40–50 microteslas in Germany. The magnetic field associated with the cable system essentially depends on the load factor, in other words the amount of electricity being passed through it. The above graphic shows, by way of example, the field at maximum capacity utilisation and in the planned layout in agricultural areas: directly above the cables and at a height of 0.2 metres above the ground, the magnetic field from ALEGrO is about 51 microteslas, and thus slightly higher than the earth's magnetic field. As the vertical and lateral distance increases, however, the field declines very quickly.

The earth's magnetic field is part of the natural environment that we humans live in. Scientists have long been investigating the effects of constant fields of this magnitude, or stronger fields associated with arc welding or working with magnetic resonance imaging (MRI) scanners in a medical environment. Germany's p. 23 **Radiation Protection Commission** obtained a summary of these studies in 2013. It concluded that there was no evidence that this type of magnetic field had any negative effect on humans, animals or plant life.

These findings were incorporated into the revised version of the 26th German Immission Control Act (BImSchV) in 2013, which set the limit value for constant magnetic fields at 500 microteslas. ALEGrO and similar DC projects fall well below this limit value.

Listening and planning

To keep the burdens in this region as low as possible through a process of good planning, we spoke with local residents and representatives of municipal authorities, rural district authorities and trade and professional associations before the official procedure even started. In the process we also fulfilled our legal requirements, under which the public must be advised of **PCI projects** and be given a fair hearing as early as possible. This ensures that the most suitable route is selected and allows the subjects that need to be dealt with in the application documentation to be established. This is also in our own interests. This approach allows many questions and problems to be possibly clarified well before the actual procedure, and the cable can be planned to ensure that its construction and operation cause as little disturbance as possible.

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Whom did we consult?

We held the first discussions in the region as soon as it became clear that ALEGrO was to be included in the 2012 Electricity **Grid Development Plan**, and also subsequently in the **German Federal Requirement Plan Act**. Our employees then met with the local residents in Niederzier, which is where the converter station for ALEGrO will be built, Alongside the existing **substation**. This event is being followed by further information evenings along the intended route, which will continue until the approval procedure has been concluded. These will allow us to present our project and, later, the progress we have made with planning – and in return we can also be alerted to any potential problems. We will draw attention to these sessions and all other scheduled events in a newsletter. You can also convey your comments and suggestions regarding the cable route to us via our **participation platform**.

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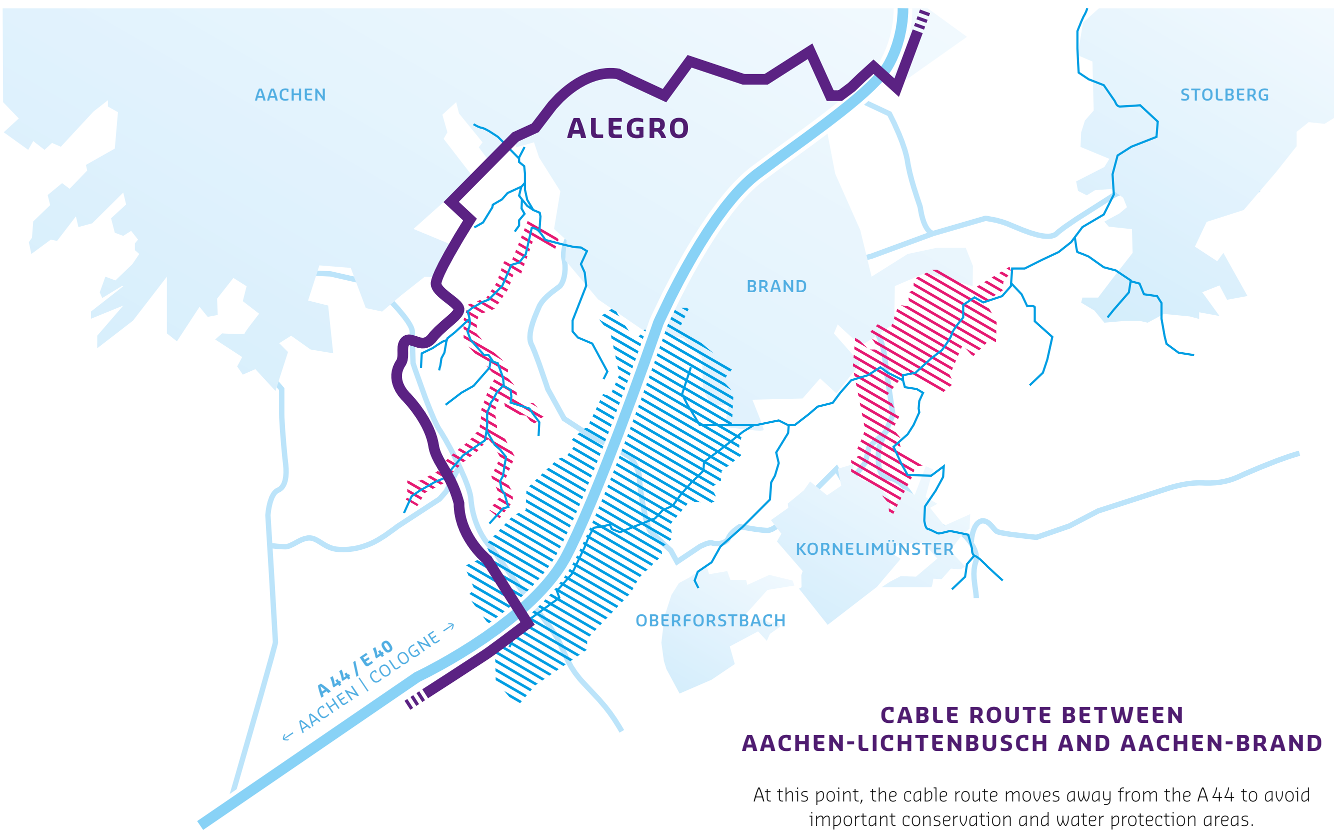
alegrodialog.de/content/information-english

How the proposal was developed

These discussions and our research have shown that the most favourable line for the cable would largely follow the A 4 and A 44 autobahns (see graphic and enclosed map). Our experts developed this proposal by weighing up the following principles, as an example:

- If at all possible, the cable route should be away from built-up areas.
- It must not run alongside or through designated development areas.
- The cable must be constructed only where the ground will tolerate both the associated construction and operation.
- As far as possible, the cable must not run through wetlands or protected areas.
- Where possible, it must be bundled with other elements of the infrastructure (for instance, roads or gas pipelines).
- Proximity to other infrastructure must not cause heating of the cable.
- There must be sufficient space for the construction work on both sides of the construction site.
- The cable must be able to run deeply enough to avoid being damaged by either ploughing or excavation work.
- There must not be too many bends in the cable in any one-kilometre length.
- And finally: the cable should be as short as possible overall. After all, as the length of the cables increases, so do the costs of construction.



CABLE ROUTE BETWEEN AACHEN-LICHTENBUSCH AND AACHEN-BRAND

At this point, the cable route moves away from the A 44 to avoid important conservation and water protection areas.

Water protection area	Conservation area / specially protected biotope	Autobahn
ALEGrO route	Running water	Road

Alternatives

The project cannot succeed without compromises. Along the A 44 between junctions 2 (Aachen- Lichtenbusch) and 3 (Aachen-Brand), for instance: that would be the shortest route to the border. But there has been a water protection area here since the 1970s. It became clear in discussions with the municipal authorities in Aachen that the city wants to improve this conservation area still further in the next few years. Running the cable around the boundaries of this conservation area would have been sufficient to avoid conflict. That was not appropriate, however, because this path would have extended across – to both the east and the west – ground that would have been poorly suited for either construction or operation. The current proposal therefore avoids the water protection area and unsuitable ground, and is longer as a result, taking the cable much closer to the city than was originally intended. However, we are constantly testing technical solutions to help us achieve an even better cable route at this point.

We are seeking to gather both criticism and suggestions regarding the cable route. The starting point for the cable, the p. 22 grid connection point, is fixed, however: Oberzier is set down as the 'socket' for this line in the **German Federal Requirement Plan Act**. From an operational engineering perspective we consider this the right decision, because the p. 23 Oberzier **substation** is particularly powerful – which is an ideal precondition for the task facing ALEGrO.

We are still testing alternatives, engaging in many discussions and further refining the cable route. In this way, we want to elaborate an ideal proposal for the cable route which will then form a basis for the Cologne Regional Government to pass a planning resolution.

The path to approval

Following the information and discussion rounds, we will work to integrate the suggestions that we receive into the route planning for the cable. As the planning authority, the Cologne Regional Government will then determine which documentation it needs to be able to reach its decision. This includes, for instance, a description of the project in layman's terms, including details on location, nature and scope, ground and soil requirements, necessity from an energy industry perspective and technical feasibility, and a description of alternative proposals or other tested potential solutions.

On this basis we will then submit an application for a **formal public planning procedure** for ALEGrO to the authorities. This step is the start of the formal approval process. And while the third-party experts and our own employees are elaborating the documentation, we will continue to advise the public about the details on-site, talk over suggestions and criticisms and record the results.

p. 22

Statements and hearings

The regional government will display the plans for one month at the offices of the local government authority in whose region the ALEGrO project is expected to have repercussions. Everyone whose interests are likely to be affected by the project will then have the opportunity to comment on the proposal. It is important for them to be able to put forward their own objections during this hearing process and within the stipulated period allowed. Objections that are made either before then or later do not have to be considered by the regional government, and cannot form the basis of a legal claim. We will therefore draw attention to the deadlines in good time, explain the plans and discuss them with all affected groups.

Once the public display period is over, the regional government will set down dates for discussion, at which everyone who has submitted an objection or a comment in good time during the public display period will have a chance to be heard, and the regional government will try to reach a consensus on this basis. The planning resolution must decide on the objections on which it is not possible to achieve an agreement. If the discussions give rise to further changes to the plan, there may be a need for a further participation session.

Decision

Following the final discussion, the authority will draw up a planning resolution in which it will weigh up all public and private interests in favour of and against the proposal and will make its decision on that basis. It may impose special conditions in terms of construction and operation in the process. The resolution must be communicated to everyone whose objections and comments were decided upon.

The regional government will also publish its decision in the municipalities. The resolution will become final if no objections are raised within the period set down by law, or if any objections raised are unsuccessful. At that point, we will be required to begin the construction work within five years, otherwise the resolution will lapse.

FORMAL PUBLIC PLANNING PROCEDURE FOR ALEGRO – SEQUENCE OF EVENTS

From Summer 2013

1

PRELIMINARY PLANNING

ADVANCE INFORMATION

Dialogue between Amprion and the public

2014

2

APPLICATION DOCUMENTS DRAWN UP BY AMPRION

Incl. proposed route, environmental report and proposals for compensation measures

ADVANCE INFORMATION

Dialogue between Amprion and the public

Spring 2015

3

APPLICATION BY AMPRION FOR FORMAL PUBLIC PLANNING PROCEDURE

Summer 2015

4

APPLICATION DOCUMENTS PUT ON PUBLIC DISPLAY BY COLOGNE REGIONAL GOVERNMENT

Opportunity to submit objections

PARTICIPATION SESSION

Public interest groups, environmental associations, state authorities and local residents who are directly affected by the project

Official public display process accompanied by further information and dialogue arrangements by Amprion

2016

5

DATE FOR DISCUSSION

Objections presented and explained to Cologne Regional Government

PARTICIPATION SESSION

Public interest groups, environmental associations, state authorities and local residents who are directly affected by the project

2016/2017

6

ROUTE ESTABLISHED

Documentation checked, interests weighed up and a resolution passed by the Cologne Regional Government on the public planning procedure regarding the definitive cable route

Glossary

Fields, electrical and magnetic
The transportation of electricity generates two types of fields: the voltage creates an electrical field and the current a magnetic field. With alternating current, the fields change periodically with the grid frequency (50 hertz), while they remain constant in the case of direct current. The maximum field strengths are generated in the immediate vicinity of the cable; they decrease rapidly as the distance increases.

Formal public planning procedure
A special procedure for the approval of major infrastructure projects such as motorways, railways, airports and high-voltage lines. For power networks, the procedure is governed by the German Energy Industry Act (EnWG ss. 43 ff.) and the Administrative Procedure Act (VwVfG s. 72 ff.). Its objective is to streamline the procedure by ensuring that only one authority is responsible for the necessary approvals. It also gives residents a more comprehensive right to be heard than is normal under other administrative documents.

German Federal Network Agency
The German Federal Network Agency (BNetzA) is the regulatory authority that maintains, supervises and encourages competition in the network markets (electricity, gas, rail). Each year, the Agency reviews and approves the Grid Development Plan of the transmission system operators and the bases for those plans, the scenario frameworks for the development of electricity generation on a rolling ten-year basis.

German Federal Requirement – Plan Act
The act comprises 36 electricity grid expansion projects that the German Federal Network Agency considers necessary and must be implemented by transmission system operators. They are deemed to be necessary from the perspective of the energy industry and are considered an urgent requirement. For these projects, the German Federal Network Agency generally implements a planning procedure at a federal level. ALEGrO is listed in the Federal Requirement Plan as project no. 30. It is identified as a pilot underground DC cable project.

www.netzausbau.de/en

Grid Overlay
The term 'grid overlay' (or grid) describes a network that overlays an existing one. In the case of a power network, this means constructing a European long-distance power network in addition to the existing national grids. The advantages would be that electricity could be transported across long distances within Europe with minimal losses. It would also be possible to balance fluctuating feed-in from renewables over a wide area and promote the single European electricity market.

Grid Development Plan

The Grid Development Plan sets down the expansion projects in the German transmission grid for the next ten years. The Grid Development Plans are elaborated by the four transmission system operators based on assumed changes in electricity generation and consumption, known as the scenario framework. The plan was first created in 2012 and is updated annually. ALEGrO is listed in the Grid Development Plan as project no. 65.

PCI

Projects of Common Interest are infrastructure projects contained in the Union-wide list, whose implementation has been recognised by the EU as being particularly urgent. The list, which is updated every two years, currently contains 248 projects. These projects apply to special conditions to accelerate the planning and approval process. At the same time, the projects must be planned transparently and with public input.

www.ec.europa.eu

Radiation Protection Commission

An expert committee called by Germany's Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety is responsible for analysing what has been learned about ionising and non-ionising radiation and establishing recommendations on that basis. Low-frequency electrical and magnetic fields count as non-ionising radiation, which is dealt with by the A 7 Committee.

www.ssk.de/en

Reactive power

The term 'reactive power' is used by physicists to describe electrical power that is used to build up magnetic fields in transformers or lines. These magnetic fields enable the electricity to flow through the conductors; reactive power could be described as a 'lubricant for the electricity network'. It is therefore very important in terms of maintaining system stability.

Substation

A node in the electricity network. Multiple high-voltage cables come together at substations. These facilities enable individual overhead lines to be connected or disconnected as required. There is also the possibility of directing the electricity via transformers – i. e. voltage converters – for further distribution to lower-voltage networks.

PARTNERS AND PARTICIPATING ENTITIES

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It is sponsored by the European Union's Infrastructure Fund.

www.amprion.net/netzausbau/alegro-hintergrund

www.elia.be/en/projects/grid-projects/alegro

ec.europa.eu/energy/infrastructure/pci/pci_en.htm

www.netzausbau.de/SharedDocs/Downloads/DE/2014/PCI-Verfahrenshandbuch.html

LEGAL INFORMATION

PUBLISHER

Amprion GmbH
Corporate Communication
Tel.: +49 (0)231 584 914 109
Fax: +49 (0)231 584 914 188
Email: info@amprion.net
www.amprion.net/en/

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3st kommunikation GmbH, Mainz

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