lumpi berndorf

MORE CAPACITY

Increase transmission performance

THERMAL RESISTANT
OVERHEAD CONDUCTORS

SPECIAL OVERHEAD CONDUCTORS

Solutions for sensitive environmental areas
and combined energy and data transmission

NOISE-REDUCTION CONDUCTORS
COATED CONDUCTORS
OPGW/OPPC

WIRES AND OVERHEAD CONDUCTORS

FOR ELECTRICAL ENERGY AND DATA TRANSMISSION

Increasingly short innovation cycles and dynamically-changing markets call for a consistent focus on the markets and the technology. Due to the constant further development of its products, LUMPI-BERNDORF has overcome this challenge with a great degree of flexibility.

Today, the special conductor designs for installing new lines and upgrading existing overhead lines are the most cost-effective answer to the requirements concerning electrical energy and data transmission.

Here numerous patents and new products, such as the „hot" TAl conductors, specially coated conductors and hollow conductors underline the innovative strength of LUMPI-BERNDORF.

With the production of wires and special overhead conductors to increase distribution and transmission performance while simultaneously reducing disruptive environmental factors, we are also a pioneer in environmental protection issues, particularly when it is a case of developing sustainable solutions for the future.

PRODUCT OVERVIEW

MORE CAPACITY

Increase transmission performance with
thermal resistant overhead conductors

THERMAL RESISTANT
OVERHEAD CONDUCTORS

MORE CAPACITY

INCREASE TRANSMISSION PERFORMANCE WITH THERMAL RESISTANT OVERHEAD CONDUCTORS

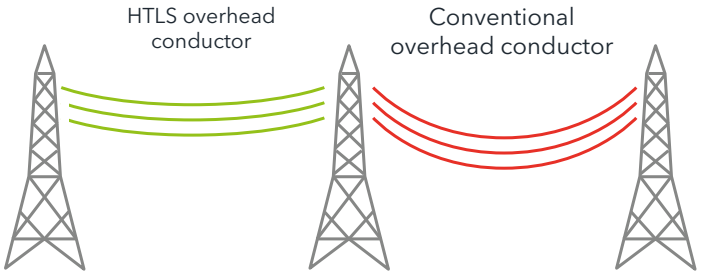
To keep pace with increased demand for energy and production from alternative sources, power grids are having to constantly expand. Given the lack of space available for new overhead line routes, it is becoming more and more important to uprate existing overhead lines.

The transmission capacity of the overhead lines must also be boosted significantly to cover peak power requirements. Generally speaking, higher operating voltages, larger conductor cross-sections and bundled conductor arrangements are not all that easy to achieve.

OVERHEAD CONDUCTORS
>100 % MORE CAPACITY

Specializing in thermal resistant overhead conductors (HTLS - High Temperature Low Sag), LUMPI-BERNDORF is able to provide a fully developed and cost-effective solution for a significant increase in transmission performance along with the highest possible sag stability.

Sag stability at higher operating temperature



THERE ARE THREE LEVELS OF CAPACITY INCREASE:

1

CONDUCTORS WITH UP TO 50 % HIGHER CAPACITY

Thanks to their aluminium zirconium alloy, these conductors allow the operating temperature to be increased to 150 °C (302 °F), resulting in a continuous current-carrying capacity that is around 50 % higher.

2

CONDUCTORS WITH UP TO 100 % HIGHER CAPACITY

These conductors also incorporate an aluminium zirconium alloy, but allow the operating temperature to be increased to an amazing 210 °C (410 °F), resulting in a continuous current-carrying capacity that is around 100 % higher.

3

SPECIAL BLACK COATING

Applying a black coating to the conductor surface increases heat emission so that even more energy can be transmitted, i.e. the continuous current-carrying capacity can be improved by another few per cent.

LUMPI-BERNDORF'S special conductor designs for constructing new overhead lines and uprating existing ones are currently the most cost-effective choice for meeting electrical energy and data transmission requirements.

DEVELOPMENT OF THE THERMAL RESISTANT OVERHEAD CONDUCTORS

As a material for manufacturing overhead conductors, aluminium has to meet a set of specific requirements:

- **maximum conductivity**
- **maximum strength**
- **controlled ageing and temperature resistance**

However, these requirements conflict with one another. Optimum conductivity values can only be achieved by using high purity aluminium, but this reduces the strength quite considerably.

To keep the strength roughly the same, dispersion-strengthened materials have to be considered. With this in mind, **aluminium zirconium alloys** are one way to create thermal resistant conductors of this kind.

Zirconium enables a higher recrystallisation temperature while at the same time increasing the strength of the conductors.

Apart from the fact that their conductivity is slightly lower, the AT1 and AT3 alloys have virtually identical properties to pure aluminium. In the case of the AT2 alloy, the reduction in conductivity was a deliberate trade-off in return for higher strength.

This is clearly illustrated by the following comparison of the characteristic values:

	Unit	AL1	AT1 [1]	AT2 [2]	AT3 [3]
Conductivity	Sm/mm²	35.38	34.80	31.90	34.80
Tensile strength	daN/mm²	16 - 20	15.9 – 17.1	22.5 – 24.8	15.9 – 17.6
Modulus of elasticity	daN/mm²	6000	6000	6000	6000
Coefficient of expansion	E-05/°C	2.3	2.3	2.3	2.3
Continuous operating temperature	**°C**	**80**	**150**	**150**	**210**
Short-time temperature (30 min)	°C	--	180	180	240
Short-circuit temperature (1 s)	°C	130/160	260	260	280

[1] AT1 according to EN62004/2009 = TAl [2] AT2 according to EN62004/2009 = KTAl [3] AT3 according to EN62004/2009 = ZTAl

Advantages of high temperature resistant aluminium alloys:

- Increase in operating temperature
- Up to > 100 % higher current carrying capacity
- Increased tensile strength

COMBINATIONS OF MATERIALS AND APPLICATION AREAS FOR THERMAL RESISTANT OVERHEAD CONDUCTORS

AT1 conductors

Just like aluminium conductors, AT1 conductors (without any steel reinforcement) are primarily used in substations.

AT1/ACS conductors

To make them suitable for use in overhead lines, AT1 wires are combined with aluminium clad steel core wires.

AT2/ACS conductors

If a stronger conductive material is required for use in overhead lines (e.g. on hilly or mountainous terrain) AT2 wires can be used.

AT1/ACI conductors

To further improve the sag properties of the conductors, a special INVAR alloy (nickel steel alloy) was incorporated into the product range.

We call this **ACI**, which stands for **A**luminium-**C**lad **I**nvar. The key benefits of this base material are that its thermal coefficient of expansion is three to four times lower than that of conventional base materials, and that the aluminium layer ensures excellent corrosion resistance.

AT1/ACI conductors exhibit much lower levels of thermal expansion, which results in significantly better sag properties.

AT2/ACI conductors

This type is ideal for use in situations where reduced sag is required in conjunction with stronger aluminium.

AT3/ACI conductors

This alternative can increase the continuous current by up to 100 %. The ACI prevents any significant increase in sag, meaning that the necessary safety distance can be adhered to.

AT1/CFCC or AT3/CFCC conductors

By using conductors with a carbon fibre composite core (CFCC), the highest possible reduction in sag is achieved. The lower core weight leads to a lower tower load and thus enables an increase in a bigger diameter.

IDEAL AREAS OF APPLICATION FOR THERMAL RESISTANT OVERHEAD CONDUCTORS

SUBSTATIONS
OVERHEAD EARTH CONDUCTORS
PHASE CONDUCTORS

Use in substations

Thanks to the short spans, no sag issues occur in spite of the high temperatures involved. AT1 conductors can be used here without any problems. The performance of existing installations can be boosted by 50 %, simply by replacing the conductors.

In contrast to conventional uprating measures, there is no need to modify the poles and extend the foundations.

Experience has also shown that the same fittings can be used as before. Thanks to their large mass and surface area, the conductor clamps reach much lower temperatures than the conductors themselves.

Use in overhead earth conductors

The excellent temperature resistance of 'hot' conductors that rely on aluminium clad steel or ACI as the base material support short-circuit temperatures of up to 280 °C (536 °F) (for 1 s), which means they can absorb much higher short-circuit currents than conventional conductors.

Up until now, very high short-circuit currents were a commonly occurring problem 1–2 km (0.6 to 1.2 miles) upstream of the substation because they often meant that conductors in the next size up had to be installed. Our conductors are an easy and cost-effective way to resolve this issue. There is no need to change the conductor size and the fittings can be retained.

Use in phase conductors

Several parameters must be taken into account within this context. Due to the increased sag that occurs at high temperatures, each project must be analyzed and planned individually.

To get the very best from thermally resistant conductors, the following issues must be clarified before embarking on any project:

- What territorial, governmental and legal regulations are there to consider?
- For how many years is this upgrade and – in turn – increase in performance intended to last?
- What level of continuous current is required?
- Materials and dimensions of existing conductor?
- Is there any spare capacity in terms of the poles?
- Is there a sag buffer?

Various alternative technical quotes can then be prepared on the basis of this project data.

Technical comparison of base materials:

	Unit	Galv. steel [1]	Aluminium clad steel [2]	ACI 14SA [3]	CFCC [4]
Modulus of elasticity	daN/mm²	20700	16200	14100	12200 - 12600
Coefficient of expansion	E-05/°C	1.15	1.30	0.45 (15-230 °C)	0.1
Tens. stress / 1 % elongation	Mpa	1100 - 1170	1000 - 1200	990 - 1070	ca. 1280
Tensile strength Rm	Mpa	1300 - 1400	1070 - 1340	1065 - 1160	2137
Elongation to 250 mm	%	3.0 - 4.0	1.5	1.5	> 1.5
Density	g/cm³	7.78	6.59	6.94	1.65

[1] Galvanised steel according to EN 50189/2000, ST1A
[2] Aluminium clad steel according to EN 61232/2000, 20SA type A
[3] ACI 14SA according to LUMPI-BERNDORF specifications
[4] CFCC - Carbon Fibre Composite Core

It is clear that thermal resistant conductors can be used to increase transmission performance. Not only that, but the characteristics of the **ACI** or **CFCC** base material have an extremely positive effect on the strength of the conductors and the sag at high temperatures - as a result, users can either opt for huge financial savings through continued use of existing routes and the associated infrastructure (towers, etc.) or for considerably higher transmission performance through the construction of new lines.

ADVANTAGES OF THERMAL RESISTANT ALUMINIUM ALLOYS

- Cost-effective renovation of existing installations thanks to increased capacity plus the ability to make use of existing routes and the associated infrastructure such as towers and their foundations
- Creation of outage reserve capacity
- Continuous current-carrying capacity is approximately 50 % to 100 % higher than with Al/St conductors with an identical cross-sectional area
- Higher short-circuit current, resulting in higher operational reliability
- Same corrosion resistance as standard conductors
- Same mechanical properties as standard conductors

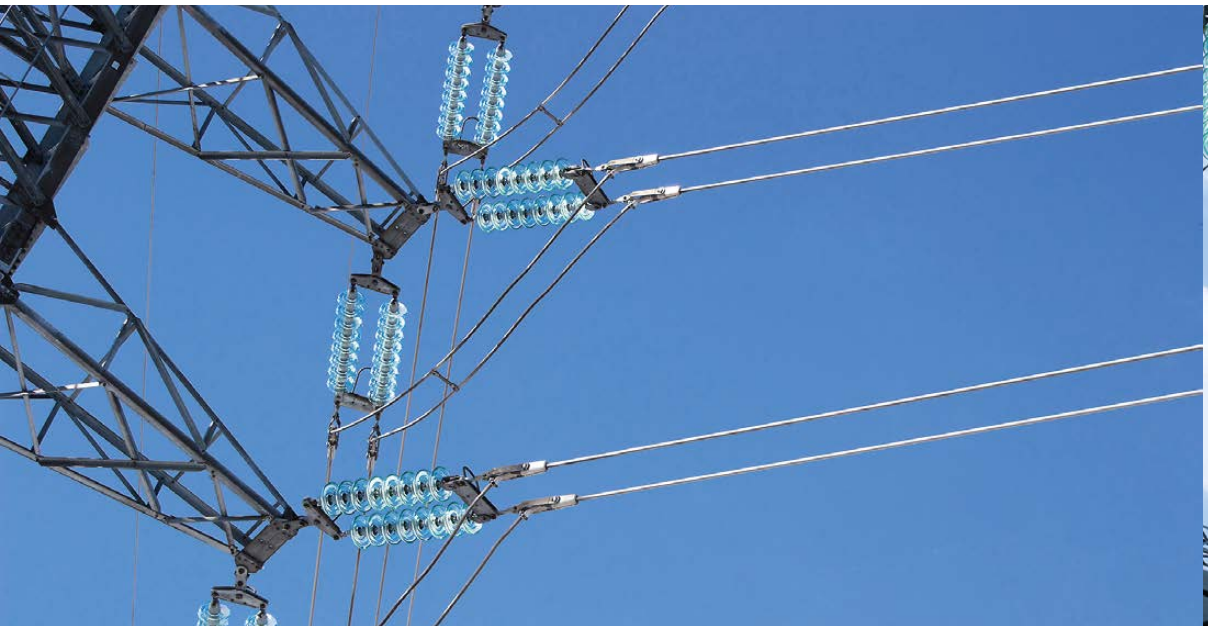
FITTINGS FOR THERMAL RESISTANT OVERHEAD CONDUCTORS

As part of the process of introducing new conductor materials for overhead line construction, the fittings must also, of course, be thoroughly checked. Ever since high-temperature conductors were first put into operation in Austria and Germany, numerous tests have been carried out to verify the retention force values involved.

These tests have revealed that the conductor clamps reach significantly lower temperatures than the conductors because of their larger mass and surface area.

Example:

Conductor temperature	150 °C (302 °F)
Clamp temperature	105 °C - 110 °C (221 °F - 230 °F) depending on clamp design



SPECIAL OVERHEAD CONDUCTORS

Solutions for **sensitive environmental areas** and combined **energy and data transmission**

NOISE-REDUCTION CONDUCTORS
COATED CONDUCTORS
OPGW/OPPC

TAKING THE TECHNOLOGICAL LEAD THROUGH CONSISTENT RESEARCH AND DEVELOPMENT

Alongside the demand for increased distribution and transmission performance in recent decades, environmental protection and sustainability have become increasingly important.

Ever shorter innovation cycles and dynamically changing markets mean we have to remain focused on the markets and the technology at all times.

Through consistent further development of its special conductor designs, LUMPI-BERNDORF has succeeded in setting new benchmarks for environmentally-friendly and cost-effective energy transport.

SOLUTIONS FOR SENSITIVE ENVIRONMENTAL AREAS

Frequently, the prerequisites for problem-free energy transport in particularly sensitive environmental areas, such as wooded and residential areas, include avoiding disruptive visual impacts and reducing noise emissions. Various innovative solutions from **LUMPI-BERNDORF,** including combinations of products, can be used to address complex tasks such as these.

TELECOMMUNICATIONS SOLUTIONS

Intelligent energy networks and the rapidly increasing demand for telecommunications solutions are increasingly placing new demands on the transmission system operators. **LUMPI-BERNDORF** also offers conductors with forward-thinking design for combined energy and data transmission in the area of telecommunications – another example of high-tech products that guarantee a smooth energy and data flow.

SPECIAL OVERHEAD CONDUCTORS

Solutions for **sensitive environmental areas**
and combined **energy and data transmission**

SPECIAL CONDUCTOR CONSTRUCTIONS
FORWARD-THINKING TECHNOLOGY

Electric high-voltage overhead lines can lead to disruptive noise emissions under certain circumstances. The use of noise-reducing overhead conductors can be an ideal solution, particularly in residential areas where special environmental measures (e.g. noise emissions) are to be taken into account.

HOLLOW CONDUCTORS
Noiseless energy transmission - high performance

Due to a special conductor construction (hollow area in centre) and the use of aluminium clad steel, aluminium and alloyed aluminium wires it is possible to replace standard conductors with hollow ones.

As such the conductor diameter is increased, while retaining the mechanical and electrical properties of the overhead lines to be replaced. Thanks to the increase in the conductor diameter and the resulting reduction in marginal field intensity, many different corona noises are significantly reduced.

ADVANTAGES:

- Reduction of marginal field intensity
- Reduction of corona noise
- No tower/foundation adaptions

LOW WEIGHT CONDUCTOR
Greater diameter - lower weight

The sophisticated conductor construction is a combination of aluminium or alloyed aluminium wires and special filling elements. Thanks to the conductor's special construction, assembly without special fittings is possible, in contrast to classic hollow cables, which means the same stringing process compared to standard conductors.

Due to the greater diameter combined with a simultaneous reduction in weight, the corona noise level is noticeably reduced. For additional optimization of noise reduction, the conductor can be provided with a hydrophilic surface.

Alongside the established bead blasted method, there is also another groundbreaking new development from LUMPI-BERNDORF available for use: colour-coating with **„SILENT BLACK COLOUR"** (see chapter ‚Surface treatments for overhead lines')

ADVANTAGES:

- Use of standard fittings
- Same stringing process as for standard conductors
- Greater diameter with the same or lower weight

Conductors with Carbon Fibre Composite Core
(CFCC - Carbon Fibre Composite Core)

ADVANTAGES:

- Highest level of sag stability
- Lower weight
- Increase of conductor diameter possible
- Optionally combinable with tubes and/or round or profiled wire

SURFACE TREATMENT FOR OVERHEAD CONDUCTORS

HYDROPHILIC SURFACE

In the event of precipitation and fog, noise development can only be reduced to a minimum by increasing hydrophilicity.

Due to increased marginal field intensity, high operating voltages sometimes lead to high/low frequency noise emissions which can be intensified in damp whether conditions.

As a measure to effectively combat corona discharge in high-voltage overhead lines, LUMPI-BERNDORF has developed several material-protecting processes to achieve a hydrophilic surface. Noise development can only be reduced to a minimum by increasing hydrophilicity.

Due to fast dispersal of water and a reduction in the number of water droplets on the hydrophilic surface, the frequency and intensity of corona discharge is significantly lowered and the resulting noise level is reduced to a minimum.

Another positive aspect is the reduction in transmission losses in overhead lines – another contributing factor to more cost-effective energy transport.

Depending on the requirements analysis, there are two processes for gentle surface treatment available:

- Bead blasted conductors
- Coated with „Silent black colour“

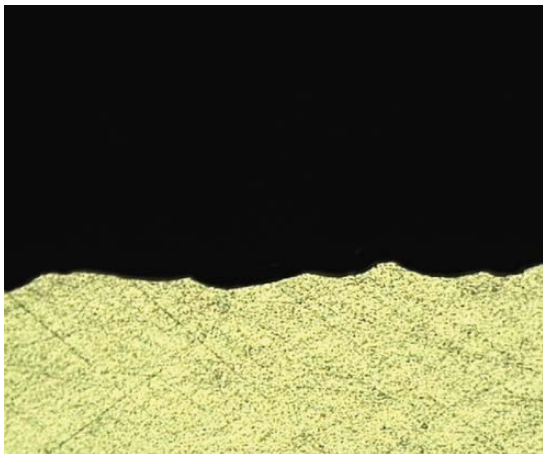
BEAD BLASTED CONDUCTORS FOR NOISE REDUCTION

Bead blasting is an extremely material-friendly process technology for achieving a hydrophilic surface and has no side effects such as radial cracking or notching due to the segment-shaped indentations. Depending on the area of application, LUMPI-BERNDORF is thus able to produce all standard conductors, high-temperature-resistant conductors and OPGW / OPPC as bead blasted variants.

243-AT1/39-A20SA high temperature resistant conductor in bead blasted version

ADVANTAGES:

- Reduced corona noise in damp climate
- Material-friendly process
- Reduction in transmission losses
- Matte diffuse surface to reduce reflections



Thanks to their spherical segment-shaped indentations, conductors treated with glass beads are not subject to side effects such as radial cracking or notching effects.

COLOURED HYDROPHILIC CONDUCTORS - SILENT BLACK COLOUR

Combination of colour-coating and noise reduction

With the aim of confronting the technological challenges of the future in closer collaboration with the customer, LUMPI-BERNDORF has set another significant milestone with the revolutionary new development of **SILENT BLACK COLOUR**.

On the left, a conductor coated with „Silent black colour" shows a clearly more hydrophilic surface compared to a standard coated conductor.

With this new method for noise reduction in overhead lines, the „**Silent black colour"** is applied to the surface of the finished conductor. The effect achieved represents a **further benefit of hydrophilicity** in comparison to bead blasting. At the same time, the coating also has a positive contribution to make to the landscape thanks to the reduced visual impact.

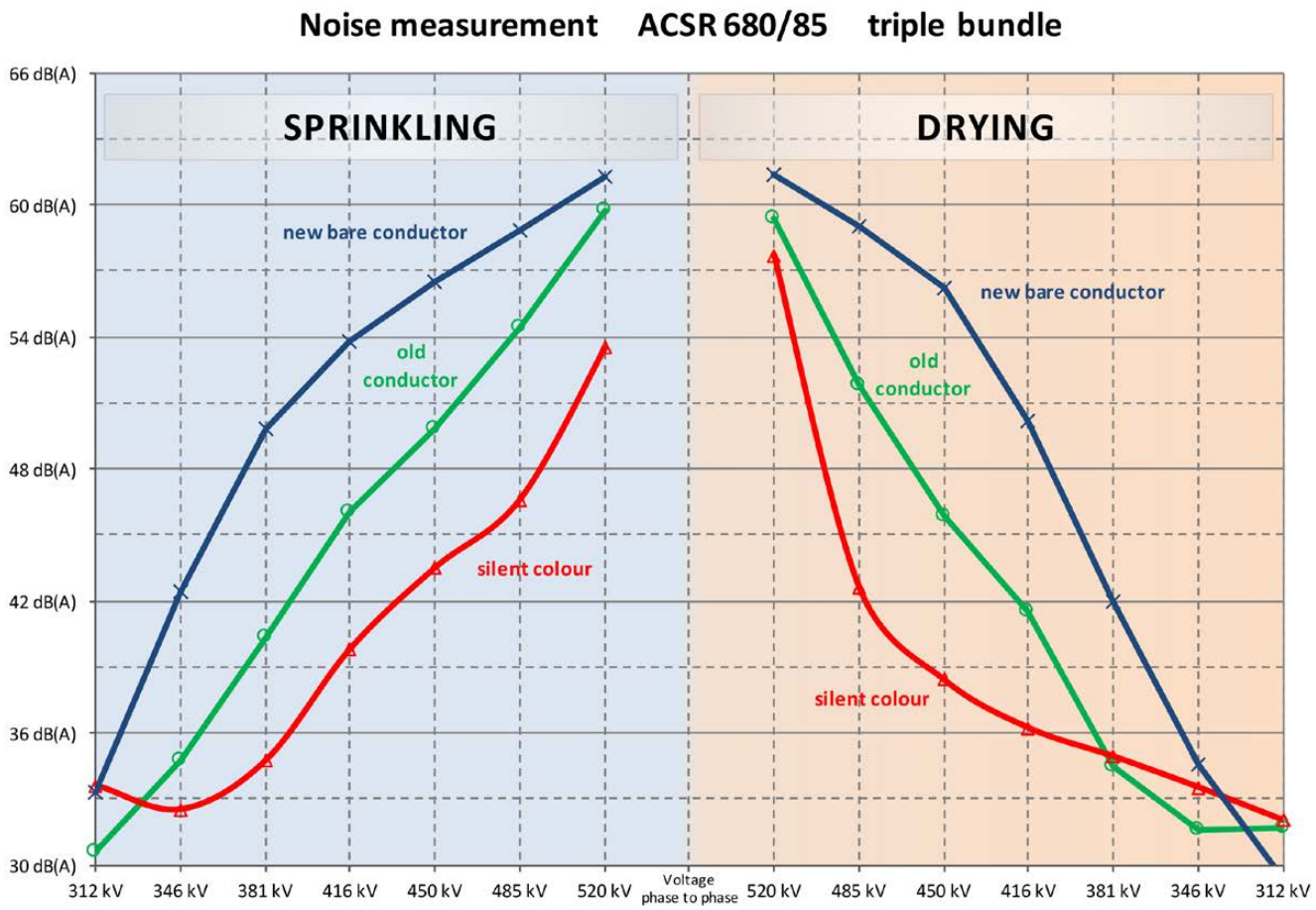
The effect achieved is a further reduction in noise emissions compared to bead blasting! A noise reduction of up to 10 dB has been proven in laboratory tests.

ADVANTAGES:

- **EXTREME REDUCTION OF CORONA NOISE LEVEL**
- Camouflage reduces visual impact on environment
- CO_2 reduced due to lower transmission losses
- Increased transmission capacity
- Reduced conductor temperature and sag
- Emission coefficient increased to 0.97
- Product features certified by independent institutes

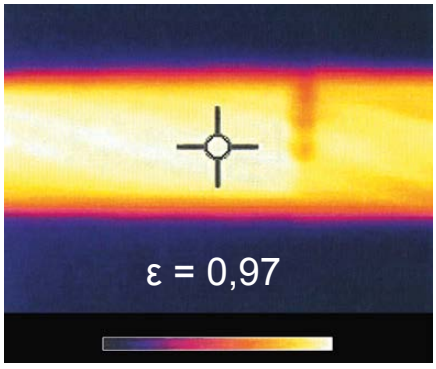
Outstanding product features

This special coating makes it possible to reduce the corona noise level by **more than 50 %** compared to new uncoated conductors. The different surfaces are compared in the diagram below.



Efficiency meets technological advancement

Cost-effectiveness, efficiency and sustainability are the key challenges for energy transport in the future, with the positive aspect of a reduction in transmission losses from overhead lines making an important contribution to efficient energy transport. We can also point to an emission coefficient of 0.97, achieved through the SILENT-BLACK-COATING, as another significant factor.



Emission coefficient of overhead conductors

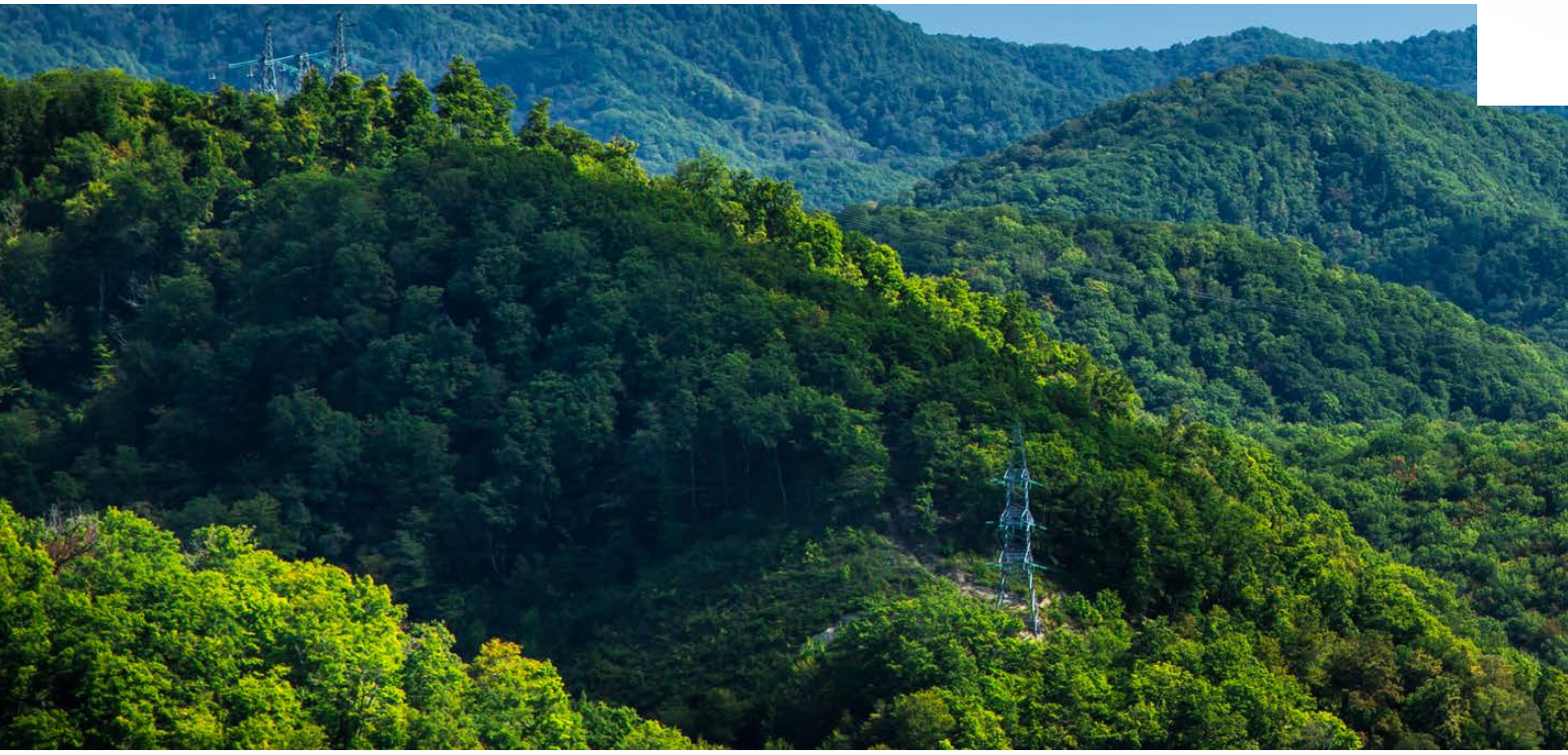
New	0.20
Bead blasted	0.40
Black colour	0.90
Silent black colour	0.97

Thanks to this almost perfect black body, it is possible to increase the transmission performance or reduce the conductor temperature and therefore also the sag.

COLOURED OVERHEAD CONDUCTORS

Developed for use as camouflage conductors and for optimization of continuous current carrying capacity

Surface treated overhead conductors



BLACK

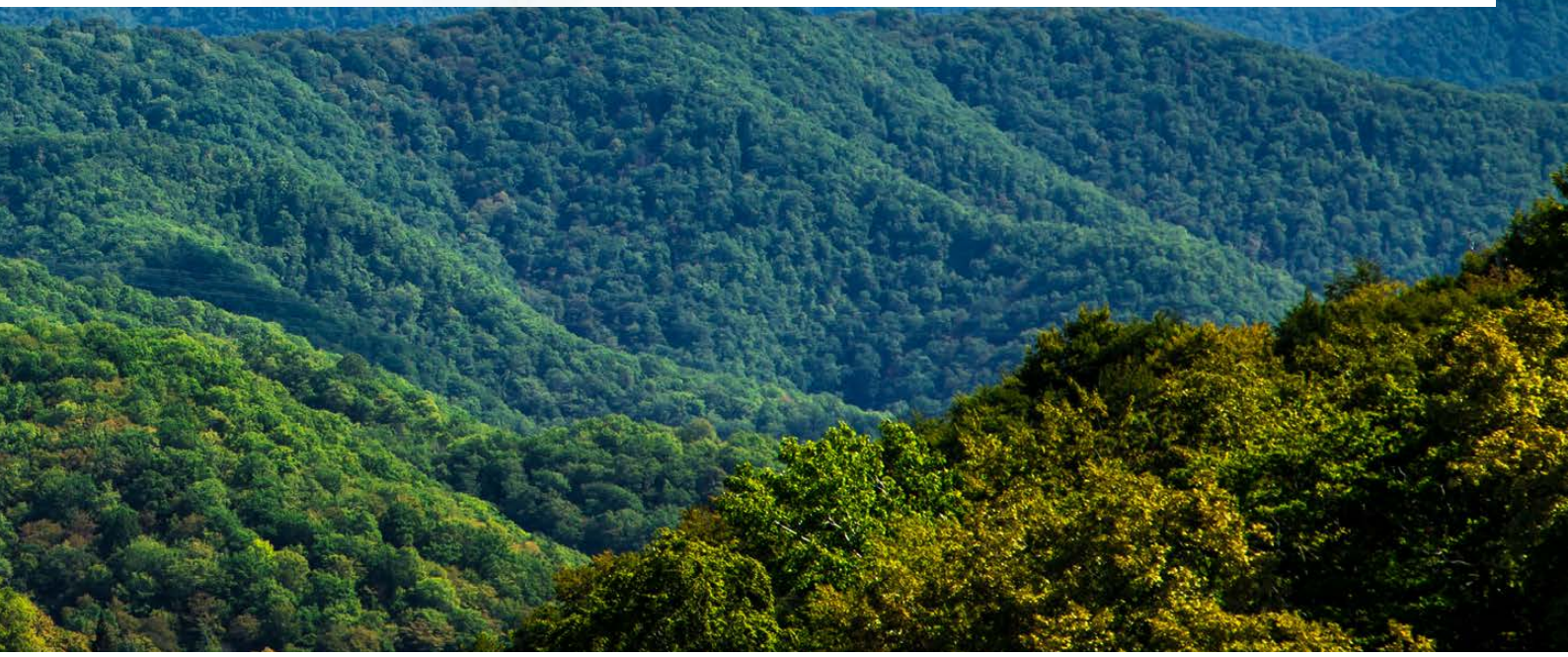
Overhead conductors with a black surface have been developed in order to optimize the operating temperature and/or the continuous current carrying capacity.

The black conductor surface brings about an improvement in the heat emission, meaning that the conductor stays significantly cooler for a given transfer performance or, conversely, more energy can be transferred at a given conductor temperature (up to 25 % more continuous current capacity).

GREEN

LUMPI-BERNDORF takes environmental protection requirements into account and, with the development of camouflage conductors for use in sensitive environmental areas, has taken another step towards sustainability.

Colour-coated conductors are almost invisible in areas with a wooded background. This means that the potentially disruptive visual impact of an overhead line is almost entirely avoided.



CONNECTING THE WORLD

unimpeded energy and
data flow via forward-looking design

OVERHEAD LINES WITH INTEGRATED OPTICAL FIBRES

OPGW / OPPC - for unimpeded energy and data transmission another high-tech product from LUMPI-BERNDORF

OPGW/OPPC conductors for combined energy and data transmission in the field of telecommunications are among the high-tech products available from LUMPI-BERNDORF. The fibre-optic conductors may be used either as earth wires or as phase conductors.

The targeted material combination of aluminium, AlMgSi and aluminium clad steel ensures that the electrical and mechanical requirements are met. Aluminium coated stainless steel tubes can also be used for specific applications.

Quality makes the difference

The actual communication elements, the optical fibres, are arranged in small stainless steel tubes. In conjunction with a moisture-repellent gel, the hermetically-sealed small steel tubes provide optimal protection against mechanical stresses and humidity. In order to make it possible to distinguish between the small stainless steel tubes, they may also be equipped with a surface marking if required.

- **Stainless steel tubes or aluminum cladded stainless steel tubes**
  (Elimination of conductor grease)
- **Enormous high fiber count due to use of special fibers**
- **Round or profiled wires**
- **Surface treatment for sensitive areas**
- **High breaking loads**

Everything from a single source for maximum fibre optic connection reliability

By using high-strength materials, great span lengths are possible (fjord and river crossings, ...). For optimal installation and long-lasting operation, we supply according to our customers needs suitable fittings and fiber optic components such as transition and inline closures, etc.

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