LAMIFIL

BREAK THE ICE LOAD

Excelling HTLS conductors
for severe climatic conditions

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THE ICE LOAD CHALLENGE

Climatic conditions have a major impact on overhead transmission and distribution lines. It has been recorded that weather accounts for about 70% of all major outages in the US alone. 'Ice loading' or the build-up of ice on power lines presents a tremendous challenge for a number of grid owners or operators. In more extreme conditions, a conductor may build up 50 mm of ice, representing an extra weight of up to 10 times the conductor weight.

Ice loads generate extra tension on the line causing it to sag more. Excessive sagging can have severe consequences, including power outages due to violation of electrical clearance distances, line breakage, tower or pole damage or even collapse.

In addition to potential line failure or damage, permanent excessive sagging is cost inefficient, as it requires the construction of either additional or taller towers, thus increasing overall line costs.

BREAKING THE ICE LOAD WITH EXCELLING HTLS CONDUCTORS

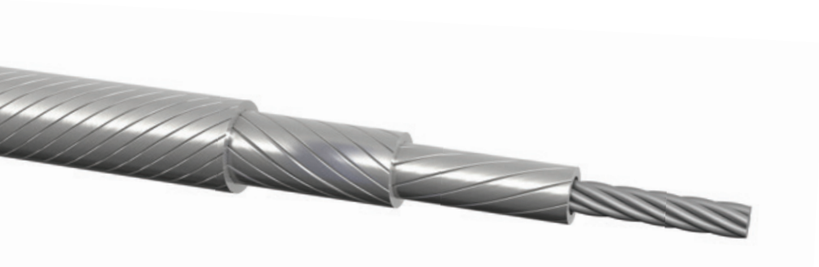
Faced with a growing demand for power and the need for upgrading infrastructure, grid operators must answer a number of challenging questions: *"How can we increase our grid capacity while guaranteeing its integrity and reliability, especially under heavy climatic conditions?"* and *"How can we upgrade cost-efficiently with minimal impact on the existing infrastructure?"*

Conductor design and choice are the cornerstone of grid reliability. Specially designed High-Temperature Low-Sag (HTLS) conductors address ice loading and capacity challenges at the same time.

> *"Conductor sag due to ice load is a major issue for grid operators."*

MEET THE GAP+ AND ACCC ICE+

Lamifil's HTLS conductors that break the ice load



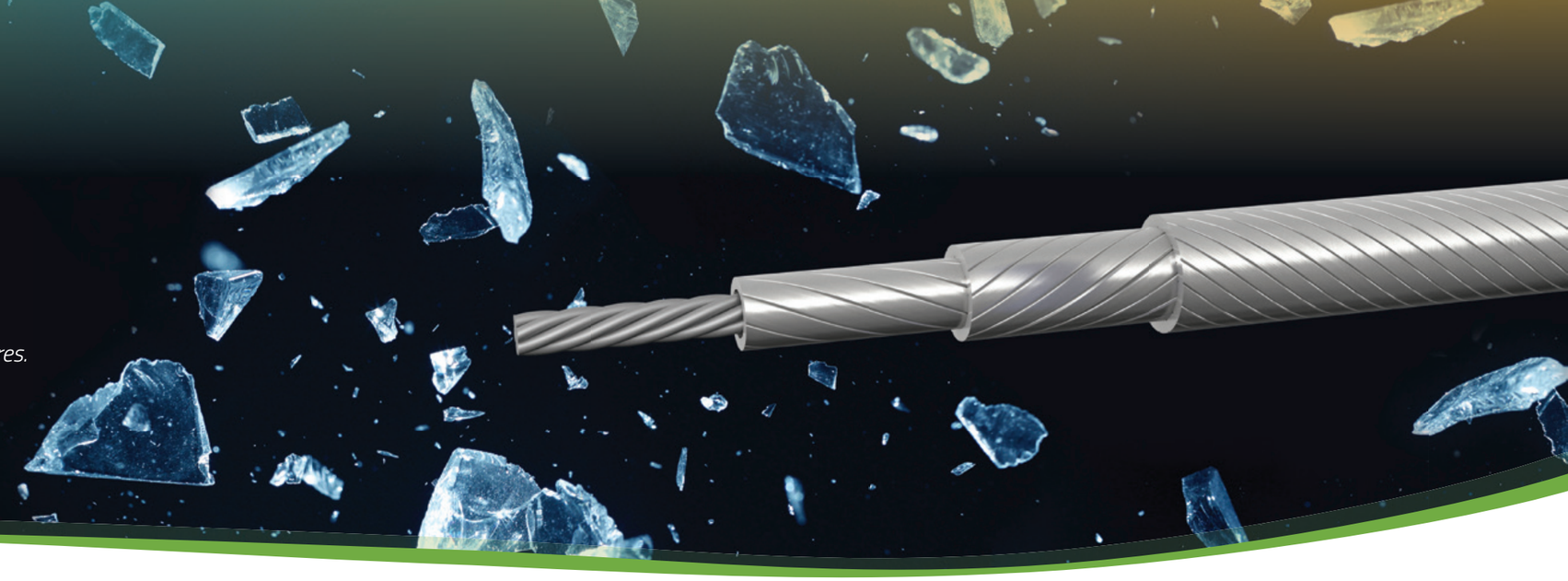
GAP+

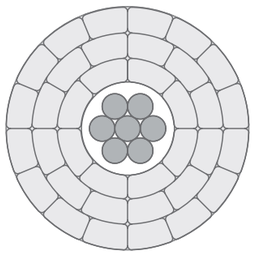
ACCC ICE+ SOFT

ACCC ICE+ HARD

GAP+

GAP+ is the superior heavy-duty conductor.
It is probably the best choice for the most severe climatic loads and temperatures.





GAP+

- Built for heavy duty
- Straightforward installation, fast commissioning
- Twice the capacity of an ASCR
- Operates up to 210°C continuously
- Withstands high ice loads and temperature sag

- Lamifil's GAP+ is the result of extensive research and testing, building on the long track record of GAP conductors.
- Available in conventional or closed designs, it uses Extra High Conductivity high temperature alloys with up to 61,5% IACS.
- Its Mega and Giga high strength galvanised steel cores are separated from the aluminium alloy by a controlled gap.
- A design that effectively reduces sag under all conditions. The combination of steel, galvanisation, aluminium and grease can resist up to 210°C continuously and 240°C emergency temperatures.

> *"GAP+ conductors have excellent sag behaviour both for high temperature and high climatic load conditions."*

ADVANTAGES

BUILT FOR TOUGH CLIMATES

GAP+ conductors have excellent sag behaviour both for high temperature and high climatic load conditions. A standard GAP+ withstands 50 mm of full density ice loads and can be designed to resist even more.

Thanks to its self-damping characteristics, GAP+ adequately reduces the effects of vibration due to wind and ice loads. On average, GAP+ demonstrates 12% less sag than an ACSS and 14% less than an ASCR under varying operating temperatures.

DESIGNED FOR LONG CROSSINGS AND LOW-PROFILE DESIGNS

As it can be designed for any size and RTS, the GAP+ conductor is well-suited for long crossings or low-profile lines. Its fixed knee point makes it an excellent choice for line designs with large span lengths. Cores with a strength of over 250kN are possible.

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INCREASED CAPACITY

GAP+ offers twice the capacity of an ACSR conductor with an equivalent load on the towers at temperatures lower than 170°C, but it can operate at up to 210°C on a continuous basis. Moreover, at low operating temperatures it is up to well over 10% more efficient than an ACSR conductor.

COST-EFFECTIVE

Overall, GAP conductors are cost-efficient HTLS conductors. Using conventional materials, they can be designed for any core strength and used in cost-effective grid upgrades.

Lamifil has developed an innovative and patented installation method for GAP+ conductors that is as straightforward as a standard ACSR installation. It requires only standard tools and equipment and works very well on rough terrain or when access to towers is difficult.

GAP+ CASE STUDY

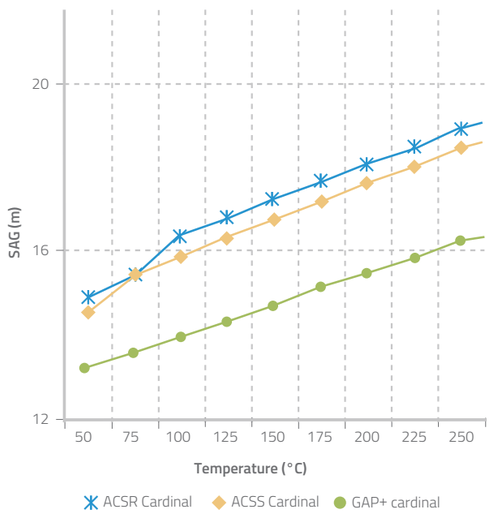
When the going gets though

THE CHALLENGE

A grid operator is confronted with a challenging line upgrade. The capacity of an existing ACSR transmission line (one circuit, twin bundle) over 110 km has to be doubled as the operator faces issues with supply security throughout the region. Equal or better line efficiency is an important requirement for the conductor chosen to replace the ACSR.

Budgetary restrictions do not allow for the reconstruction of towers. Moreover, a solution needs to be found for a long valley crossing. The terrain is rough and weather conditions place frequent strain on the grid. During winter, up to 50 mm of high-density ice loading is not uncommon on certain sections of the line. To address the effects of ice load, the operator has calculated that the sag under high ice conditions needs to be reduced by 10% compared to the existing ASCR conductor. The new line should also be at least as, if not more efficient, than the old ACSR at its rating current. A solution involving one single conductor technology, albeit in different sizes, is preferred.

SAG VS. TEMPERATURE

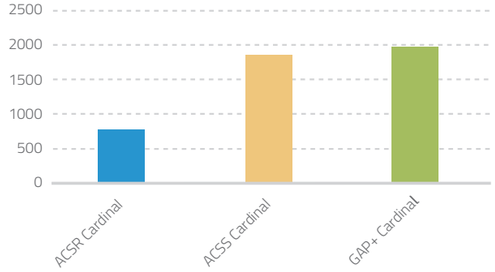


THE CHOICE FOR GAP+

In spite of the challenges of the surrounding area, the operator needs the project commissioned within a short timeframe and within the tight budget. After thorough consideration, the GAP+ conductor is selected for the project for a number of reasons. First of all, it meets the requirements for both the capacity upgrade and tower load conditions while demonstrating excellent sag behaviour and thermal ratings.

Built from robust materials with which the operator is familiar, GAP+ offers excellent value for money within the allocated budget for this project.

CURRENT AT MAXIMUM OPERATING TEMPERATURE



HOW GAP+ MAKES A DIFFERENCE

Thanks to its straightforward installation method, the difficult terrain and short commissioning timeframe were no issue for the GAP+ conductor. Built for heavy duty, GAP+ withstands high ice loads and temperature sag while offering high capacity and robustness.

Specifically, the GAP+ conductor (at 150°C) doubles the capacity of the ACSR (at 75°C) from 810A to 1620A. When both conductors run at the same current, the GAP+ is 16% more efficient. This equals a yearly cost saving of approximately € 3480 per km or in this particular case approximately € 2,3 million annually for the entire line. When both conductors run at e.g. 75°C, the GAP+ runs at 8% higher capacity, from e.g. 810A to 875A.

The GAP+'s sag at highest load is 11% lower than the ACSR for the same load. Moreover, the design can easily be adapted to deliver even higher load performance in exchange for minimal reductions in capacity.

The GAP+ conductor is 5 to 10% stronger than its ACSR or ACSS equivalents and is less prone to damage in rough terrain thanks to its hard-drawn wires in the outer layer.

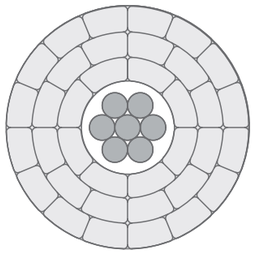
The long crossing was also not a problem for the GAP+ since the core strength could be doubled without increasing the conductor weight. This was achieved thanks to the stranded nature of the core at the expense of the aluminium section. The required current was subsequently reached at just 200°C and the decrease in efficiency was isolated to just the crossing without effecting the rest of the line.

Overall, the GAP+ conductor proved to be the best upgrade choice for this grid operator's challenging requirements.

CONDUCTOR COMPARISON				
Cardinal		**ACSR**	**ACSS**	**GAP+**
Conductor specifications				
Overal diameter	mm	30,42	30,42	29,6
Weight	kg/km	1.906,0	1.906,0	1.962,0
Strenght (RTS)	kN	149,0	152,5	166,3
DC resistance at 20°C	Ohm/km	0,060	0,058	0,050
Conductor performance and efficiency				
Maximum operating T	°C	75	210	210
Current at maximum operating T	A	811	1.845	1.966
Improvement of current at max T	%		127,5%	142%
Current calculations with environment Temp: 40°C; wind velocity = 0,6m/s; Emissivity = Absorption coefficient = 0,5; Sun radiation = 1000W/m²; Assumption:"Cost of 1MWh = 50 euro				
Joule losses				
Joule losses (811 A; 50Hz)	W/km	48.370	46.490	40.426
Temperature at given current	°C	75,0	74,0	71,0
Improvement of Joule losses	%		4%	16%
Total cost Joule losses	€/km	21.186 €	20.363 €	17.707 €
Yearly cost savings per km conductor	€/km		823 €	3.479 €
Greenhouse gass reduction				
CO_2 reduction	%		4%	16%

ACCC ICE+

ACCC ICE+ are lightweight, strong and super-efficient HTLS conductors, whose efficiency is unsurpassed in challenging climatic circumstances.



ACCC ICE+

- The most efficient HTLS conductor
- ULS design is 35% to 40% stronger than the comparable ACSR
- Up to 10% better efficiency than ACSR at low operating temperatures
- Uses exactly the same fittings as the standard annealed aluminium conductors
- Superior sag behaviour requires less towers

The high-caliber ACCC ICE+ conductors are based on the ACCC® design. They present improved features developed by Lamifil and are available in a soft thermal aluminium version – ACCC ICE+ Soft - and hard thermal aluminium version – ACCC ICE+ Hard.
They feature high-strength, temperature-resistant composite cores that can operate continuously at 180°C. Trap and/or Z-shaped aluminium zirconium wires in a closed design are stranded around the cores.
In spite of their low weight and depending on the design, ACCC ICE+ conductors are 20% to 40% stronger than comparable ACSR or ACSS conductors. 10% of that strength is attributable to the use of a composite core and even 30% in the case of a ULS composite core. Lamifil's soft or hard thermal aluminium adds another 10% (at 63% IACS) or 15% (at 61% IACS) strength respectively.

> *"Composite core conductors can be designed and optimised for maximum electrical or mechanical loads."*

ADVANTAGES

HIGHLY CUSTOMISABLE

Composite core conductors can be designed and optimised for maximum electrical or mechanical loads by choosing the right combination of aluminium and core type. In addition to the standard series, custom designs are also possible.

SUPER-EFFICIENT

ACCC ICE+ Soft and ACCC® conductors are the most efficient among all HTLS conductors and run 30°C cooler at the same current. At low operating temperatures, they improve efficiency by up to 25% compared with an ACSR.

HIGH PERFORMANCE UNDER CLIMATIC LOADS

ACCC ICE+ can be designed to withstand a 50 mm full-density ice load. Both ACCC ICE+ Soft and ACCC® conductors can be pre-stretched during installation and will then demonstrate self-damping characteristics that reduce the effects of vibration.

CONVENIENT

ACCC ICE+ Soft conductors use exactly the same fittings as normal ACCC® conductors. Overall, composite core conductors are just as easy to install with conventional methods.

ACCC ICE+ SOFT CASE STUDY

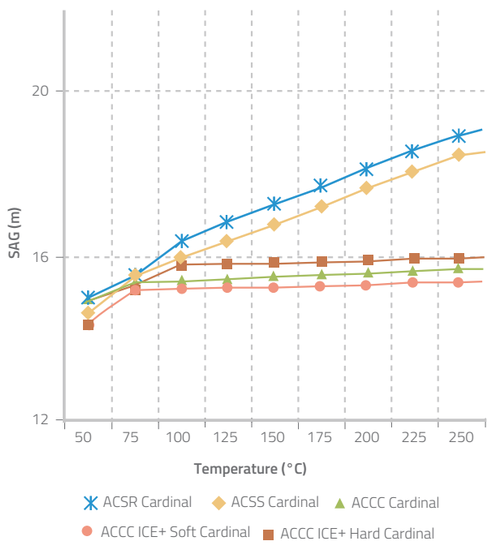
Light weight for efficient heavy lifting

THE CHALLENGE

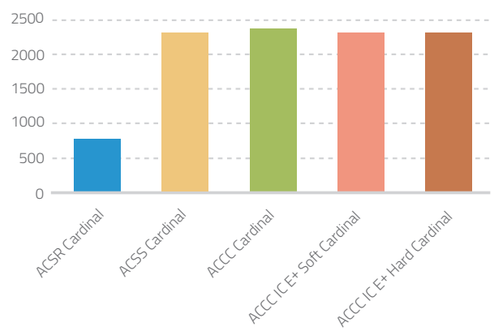
A new line project spanning 80 km (one circuit, twin bundle) on partly existing towers in a northern coastal area needs to be extended and upgraded. The operator needs to double the line capacity over the short term. The new line should also deliver the highest possible efficiency. The predicted annual average electrical load on the line is high and line losses are an economic and environmental concern for this utility.

Due to the tough climatic conditions, a total distance of about 19 miles of the existing section of the line are expected to be frequently exposed to 50 mm high-density ice loads. The calculated sag for high ice load should be at least 5% less than with the reference ACSR conductor. As environmental constraints exist, and time and capital expenditure are limited, fewer towers are to be constructed in the newly built part of the line.

SAG VS. TEMPERATURE



CURRENT AT MAXIMUM OPERATING TEMPERATURE



THE CHOICE FOR ACCC ICE+ SOFT

The operator realises that conductor choice is crucial in safeguarding the reliability and efficiency of the new line. The project would greatly benefit from a solution comprising a single conductor type and size. To address these challenges, the operator ultimately chooses the ACCC ICE+ Soft ULS conductor after careful comparison. This composite core conductor offers superior efficiency while performing very well under ice loads. It also allows the operator to use fewer towers in the new part of the line.

HOW ACCC ICE+ SOFT MAKES THE DIFFERENCE

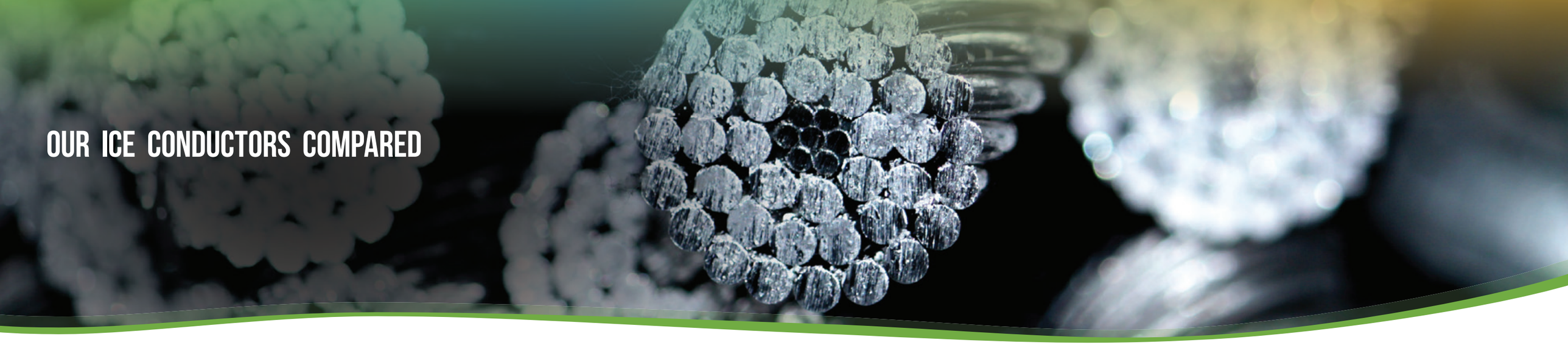
For this project, the ACCC ICE+ Soft offers the best combination of capacity, high efficiency and optimal sag under ice loads.

The ACCC ICE+ Soft ULS (at 135°C) has twice the capacity of an ACSR (at 75°C), 1620A compared to 810A. At 75°C the ACCC ICE+ Soft ULS conductor reaches 16% more capacity than the ACSR. Running at the same current as the ACSR (at 75°C) the ACCC ICE+ Soft ULS is 27% more efficient. This equals a yearly cost saving of € 5725 per km or nearly € 2,75 million over the entire line.

The ACCC ICE+ Soft ULS design is 35% to 40% stronger than the comparable ACSR. Under the highest load, the ACCC ICE+ Soft sags 6% less than an ACSR. Hence, for the new section of the line which is still to be built, the ACCC ICE+ Soft design requires 10 towers (5%) less than an ACSR. Moreover, thanks to the superior sag behaviour, the height of the new towers could be reduced by approximately 2 meters. This represents a significant cost saving in tower construction alone.

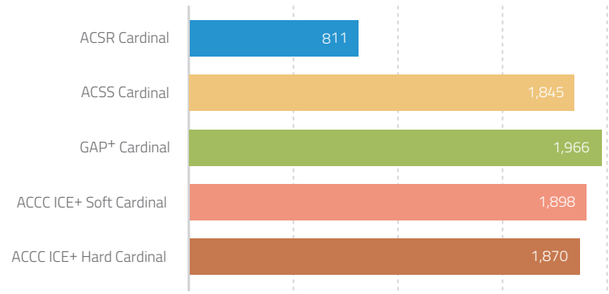
The combination of soft aluminium and a ULS composite core makes the ACCC ICE+ Soft ULS the ideal lightweight, super-efficient conductor capable of breaking the ice load burden.

CONDUCTOR COMPARISON				
Cardinal		**ACSR**	**ACSS**	**ACCC ICE+ Soft**
Conductor specifications				
Overal diameter	mm	30,42	30,42	30,42
Weight	kg/km	1.906,0	1.906,0	1.874,0
Strenght (RTS)	kN	149,0	152,5	182
DC resistance at 20°C	Ohm/km	0,060	0,058	0,044
Conductor performance and efficiency				
Maximum operating T	°C	75	210	175
Current at maximum operating T	A	811	1.845	1.898
Improvement of current at max T	%		127,5%	134%
Current calculations with environment Temp: 40°C; wind velocity = 0,6m/s; Emissivity = Absorption coefficient = 0,5; Sun radiation = 1000W/m²; Assumption:"Cost of 1MWh = 50 euro				
Joule losses				
Joule losses (811 A; 50Hz)	W/km	48.370	46.490	35.296
Temperature at given current	°C	75,0	74,0	68,0
Improvement of Joule losses	%		4%	27%
Total cost Joule losses	€/km	21.186 €	20.363 €	15.460 €
Yearly cost savings per km conductor	€/km		823 €	5.726 €
Greenhouse gass reduction				
CO_2 reduction	%		4%	27%

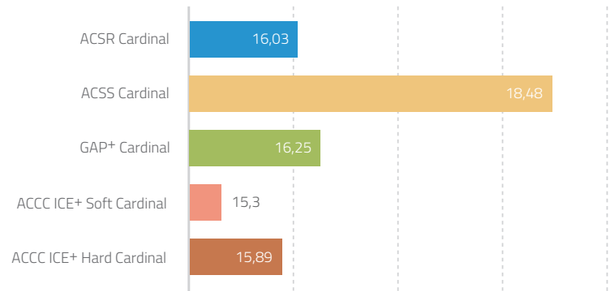


OUR ICE CONDUCTORS COMPARED

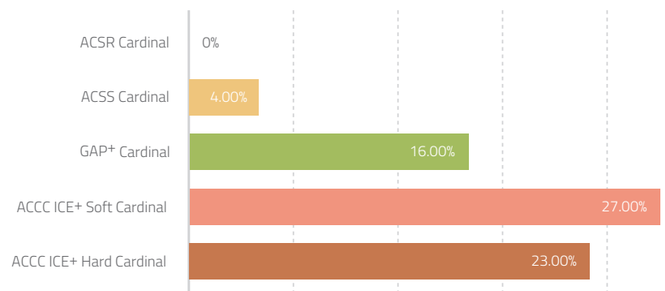
CONDUCTOR COMPARISON						
Cardinal		ACSR	ACSS	GAP+	ACCC ICE+	
					Soft	Hard
Conductor specifications						
Overal diameter	mm	30,42	30,42	29,6	30,42	30,42
Weight	kg/km	1.906,0	1.906,0	1.962,0	1.874,0	1.874,0
Strenght (RTS)	kN	149,0	152,5	166,3	182	188,7
DC resistance at 20°C	Ohm/km	0,060	0,058	0,050	0,044	0,046
Conductor performance and efficiency						
Maximum operating T	°C	75	210	210	175	175
Current at maximum operating T	A	811	1.845	1.966	1.898	1.870
Improvement of current at max T	%		127,5%	142%	134%	131%
Current calculations with environment Temp: 40°C; wind velocity = 0,6m/s; Emissivity = Absorption coefficient = 0,5; Sun radiation = 1000W/m²; Assumption:"Cost of 1MWh = 50 euro						
Joule losses						
Joule losses (811 A; 50Hz)	W/km	48.370	46.490	40.426	35.296	37.152
Temperature at given current	°C	75,0	74,0	71,0	68,0	69,0
Improvement of Joule losses	%		4%	16%	27%	23%
Total cost Joule losses	€/km	21.186 €	20.363 €	17.707 €	15.460 €	16.273 €
Yearly cost savings per km conductor	€/km		823 €	3.479 €	5.726 €	4.913 €
Greenhouse gass reduction						
CO_2 reduction	%		4%	16%	27%	23%



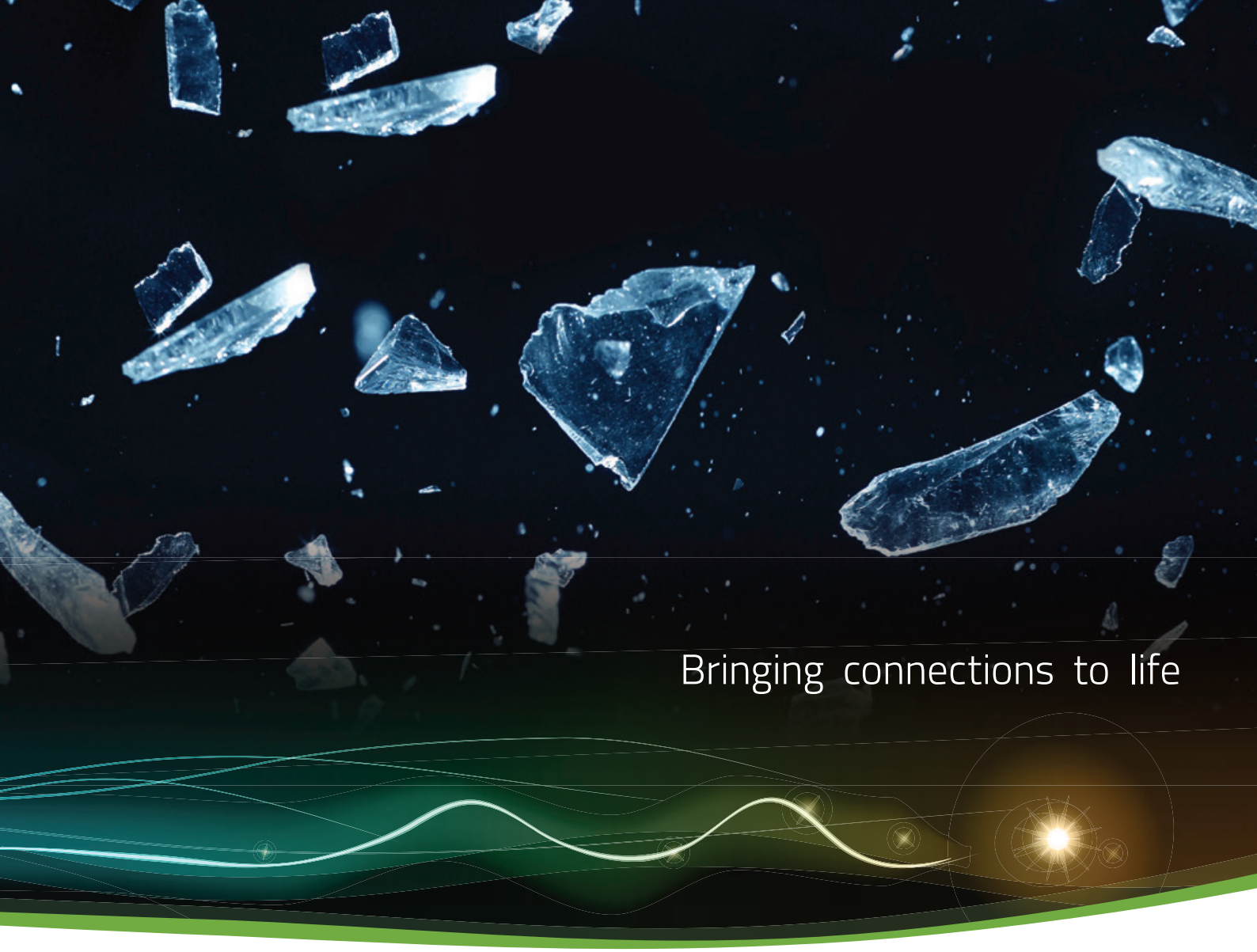
CURRENT AT MAXIMUM OPERATING TEMPERATURE



SAG AT MAXIMUM TEMPERATURE



EFFICIENCY IMPROVEMENT (CO_2 REDUCTION)



LAMIFIL

At Lamifil, 90 years of technology, innovation and mastery are forged into smart wires that bring connections to life. Today, Lamifil is one of the world's leading manufacturers of high-end cables, wires and wire-based products in copper v aluminium and their alloys. We help supply energy to millions of people with high-tech overhead conductors. Our catenary wires make trains run more efficiently in dozens of countries. Our innovative alloys are used in superior semi-finished products for the steel, automotive, aviation, aerospace and consumer products industry. Lamifil has production sites in Hemiksem (Belgium), close to the port of Antwerp, and in Uglich (Russia).

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