ENTSO-E Position Paper

The use of internal lead sheathing in power cables

November 2021

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ENTSO-E Mission Statement

Who we are

ENTSO-E, the European Network of Transmission System Operators for Electricity, is the **association for the cooperation of the European transmission system operators (TSOs)**. The 42 member TSOs, representing 35 countries, are responsible for the **secure and coordinated operation** of Europe's electricity system, the largest interconnected electrical grid in the world. In addition to its core, historical role in technical cooperation, ENTSO-E is also the common voice of TSOs.

ENTSO-E **brings together the unique expertise of TSOs for the benefit of European citizens** by keeping the lights on, enabling the energy transition, and promoting the completion and optimal functioning of the internal electricity market, including via the fulfilment of the mandates given to ENTSO-E based on EU legislation.

Our mission

ENTSO-E and its members, as the European TSO community, fulfil a common mission: Ensuring the **security of the interconnected power system in all time frames at pan-European level** and the **optimal functioning and development of the European interconnected electricity markets**, while enabling the integration of electricity generated from renewable energy sources and of emerging technologies.

Our vision

ENTSO-E plays a central role in enabling Europe to become the first **climate-neutral continent by 2050** by creating a system that is secure, sustainable and affordable, and that integrates the expected amount of renewable energy, thereby offering an essential contribution to the European Green Deal. This endeavour requires **sector integration** and close cooperation among all actors.

Europe is moving towards a sustainable, digitalised, integrated and electrified energy system with a combination of centralised and distributed resources.

ENTSO-E acts to ensure that this energy system **keeps consumers at its centre** and is operated and developed with **climate objectives** and **social welfare** in mind.

ENTSO-E is committed to use its unique expertise and system-wide view – supported by a responsibility to maintain the system's security – to deliver a comprehensive roadmap of how a climate-neutral Europe looks.

Our values

ENTSO-E acts in **solidarity** as a community of TSOs united by a shared **responsibility.**

As the professional association of independent and neutral regulated entities acting under a clear legal mandate, ENTSO-E serves the interests of society by **optimising social welfare** in its dimensions of safety, economy, environment, and performance.

ENTSO-E is committed to working with the highest technical rigour as well as developing sustainable and **innovative responses to prepare for the future** and overcoming the challenges of keeping the power system secure in a climate-neutral Europe. In all its activities, ENTSO-E acts with **transparency** and in a trustworthy dialogue with legislative and regulatory decision makers and stakeholders.

Our contributions

ENTSO-E supports the cooperation among its members at European and regional levels. Over the past decades, TSOs have undertaken initiatives to increase their cooperation in network planning, operation and market integration, thereby successfully contributing to meeting EU climate and energy targets.

To carry out its **legally mandated tasks**, ENTSO-E's key responsibilities include the following:

- Development and implementation of standards, network codes, platforms and tools to ensure secure system and market operation as well as integration of renewable energy;
- Assessment of the adequacy of the system in different timeframes;
- Coordination of the planning and development of infrastructures at the European level (Ten-Year Network Development Plans, TYNDPs);
- Coordination of research, development and innovation activities of TSOs;
- Development of platforms to enable the transparent sharing of data with market participants.

ENTSO-E supports its members in the **implementation and monitoring** of the agreed common rules.

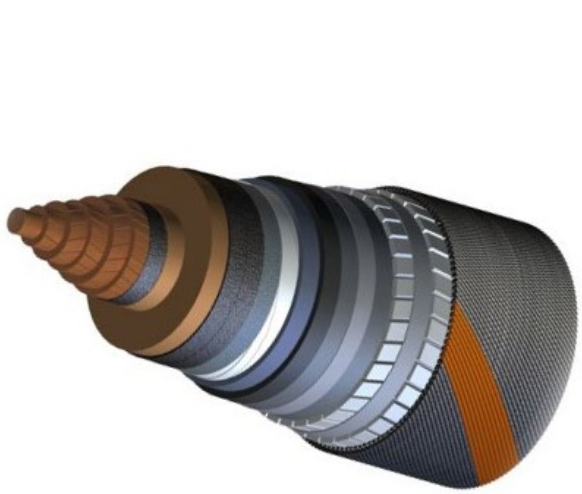
ENTSO-E is the common voice of European TSOs and provides expert contributions and a constructive view to energy debates to support policymakers in making informed decisions.

Introduction

The environmental and human health protections governing the safe use of chemicals are of fundamental concern for European TSOs. Recently, lead has been added to the European Chemical Agency (ECHA) candidate list as a "Substance of Very High Concern" (SVHC) due to the risk of damage to the central nervous system, blood and kidneys, and for being toxic to human reproduction and aquatic life[1]. For this reason, lead is potentially a candidate for future inclusion in the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Annex, which will make its usage in power cables subject to a strict authorisation process.

A possible restriction or extensive authorisation processes for lead usage in high voltage and extra high voltage power cables increases the risks of delay to presently planned cable projects. Reducing the use of internal lead sheathing in power cables requires time and is a sensitive issue that must be addressed diligently and consistently in light of the significant technical and socioeconomic impact it will have on the cable industry and TSOs. Therefore, possible reduction of the use of lead in cables should be done in a controlled manner.

In certain power cable types, to avoid water ingress and to contain the insulation system, cover of a longitudinal internal lead sheath is applied during manufacturing. To protect the internal lead sheath and provide additional mechanical strength, a sheath of strong polyethene is applied over it and further extended for subsea cables, with an additional metal armouring consisting of one or two layers of metal armouring in combination with polypropylene yarn. Covered by the protective polyethene sheath, internal lead sheathing in an underground or subsea cable has no direct contact with the environment during normal operation. Apart from manufacturing and decommissioning, direct contact with humans is only possible when performing joints, terminations and cable repairs. In the event of severe external damage causing a rupture of the outer protection, lead may be exposed to nature. In such limited cases, repair operations are performed with urgency, by certified staff, strictly applying the industry repair standards and thus effectively limiting the exposure of lead to the environment.



1 Source: ECHA C&L Inventory. Available online at: https://echa.europa.eu/information-on-chemicals/cl-inventory-database, accessed on 22 June 2020

1. Recommendations

ENTSO-E is aware of the material properties of lead as well as its potential human and environmental impact and understands the necessity to reduce its use. In the next 10 years, thousands of kilometres of new high voltage direct current (HVDC) and high voltage alternating current (HVAC) cables are expected to be installed. According to the Ten-Year Network Development Plan (TYNDP) list of projects, approximately 46,000 kilometres of underground and submarine cables are expected to be installed in Europe before the year 2030

For some underground and many subsea cable applications, no suitable alternatives to internal lead sheathing are expected to be developed in this period. In this context, from the perspective of ENTSO-E, power cables with internal lead sheathing are required to timely realise the goals of the European Green Deal, integrate the renewable energy generation, improve the European electricity market, and increase power grid stability through enhanced interconnectors between countries.

For these reasons, ENTSO-E recommends that policymakers grant unrestricted approval for the usage of internal lead sheathing in cables in the following fields and applications until alternative solutions are available and applicable:

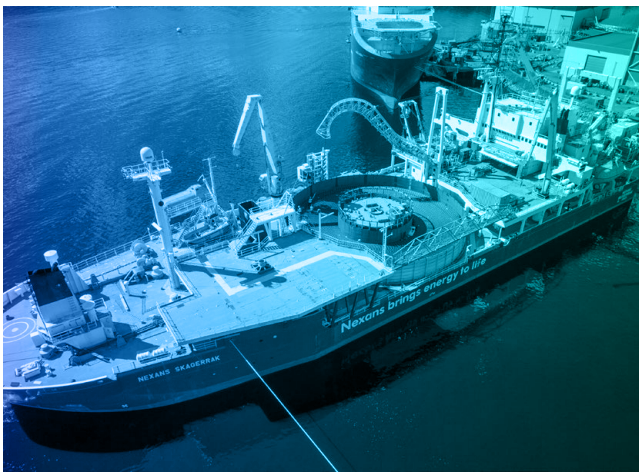
- Subsea HVAC power cables above 66 kV
- Subsea and underground cables for HVDC applications with mass impregnated (MI) insulation
- Subsea cables for HVDC applications with polymer insulation
- HVAC and HVDC underground cables installed in a polluted environment or very wet conditions with high aluminium sheath corrosion risk
- Spare parts for the maintenance and repair of existing assets

In parallel, the funding of the development of lead-free solutions by the Horizon Europe program would be instrumental in further supporting the development of alternative solutions for the areas and applications listed above.

2. ENTSO-E Actions

ENTSO-E plans to take the following actions to reduce the use of internal lead sheathing in the power cable industry within the upcoming decades:

1. Establish a cooperation and a creation of a common roadmap between TSOs and power cable manufacturers for a human and environmentally friendly lead-free underground and subsea cable development for high voltage applications. Set up milestones for the development of alternatives on each market application and periodic assessment of the development process for lead-free underground and subsea cable development. As part of the roadmap development, potential and relevant possible studies, R&D projects as well TSO pilot projects for testing new cable designs in real conditions could be identified.
2. Strengthen the use of lead-free cables in application where feasible proven alternatives exist.
3. Encourage transparency and responsibility throughout the whole life cycle of internal lead sheathing in power cables (from the handling of raw material, manufacturing, installation to de-commissioning) by both manufacturers and TSOs by using, for example, the circularity indicators methodology or similar.
4. Explore ways to promote lead-free solutions by TSOs in the tendering process.



3. Technical Background

3.1 Technical Background for the use of internal lead sheathing in HVAC power cables

In general, the insulation in all HVAC power cables has to be protected against water ingress by a completely watertight sheath; lead is currently by far the best material for that purpose.

For underground cables, progress in the quality of aluminium applying methods and the water tightness properties have gradually made it possible for aluminium to become more common than lead. For subsea cables and for underground cables in very wet or polluted areas, the use of internal lead sheathing is still necessary as the quality of aluminium is not sufficient to provide water ingress protection in the long term (normally the specified cable lifetime is more than 40 years). Lead provides a far better water tightness and corrosion performance, has good flexibility, and has an easier manufacturing process for long lengths.

Approximately 10 years ago, a so called “wet design” subsea cable was developed for voltages up to 66 kV. The main reason was to get a lighter and cheaper subsea cable for the offshore wind industry. This design does not require an internal lead sheath as a radial water barrier as its insulation compounds are designed to operate under wet conditions.

For AC subsea cables and underground cables installed in very wet or polluted areas for voltages above 66 kV, lead for internal sheathing remains the only currently available and proven solution that is completely watertight over the entire lifetime of the cable.

3.2 Technical Background for the use of internal lead sheathing in HVDC power cables

Similar to HVAC cables, the insulation system in all HVDC power cables has to be protected against water ingress. Lead is the best material for that purpose and is currently the only solution for submarine cables. For MI cables, the lead sheath is even a part of the mechanical construction of the cable and the insulation system.

HVDC cables are commonly used in long distance interconnectors (for example the ongoing construction of the HVDC subsea cable between Denmark and UK, consisting of 2 cables of 750 km each, where the weight of lead constitutes roughly 20 % of the total cable weight). The most common cables for HVDC have been MI cables, where the paper in the insulation is impregnated with high viscosity oil. For underground or subsea MI cables, there are no other alternatives to the use of lead as the internal lead sheath is part of the insulation technology in these cables and not just a water intrusion barrier.

Polymer insulation material has also been developed for HVDC cables. For underground HVDC cables of this type, aluminium is commonly used as a water barrier. In contrast, for submarine purposes and very wet or polluted soils, the usage of lead for internal sheathing is necessary to prevent water intrusion. It should be noted that the wet design concept has not been envisaged for HVDC applications as dielectric performance under the DC field is different compared to the AC field and requires the development of new solutions.

3.3 Lead is necessary for the repair of existing and upcoming HV power cables

From a power system stability, availability and sustainability perspective, the repair possibility in the entire lifespan of thousands of kilometres of existing and future power subsea and underground cables is extremely important. The established practise for cable repair preparedness for many upcoming decades is to ensure the availability of suitable and qualified repair joints and spare cables.

Presently, thousands of kilometres of subsea and underground cables with internal lead sheaths are in operation and have not reached the expected end of life yet. However, they are going to be operated for the next decades. Therefore, for maintenance and repair purposes, the on-stock repair joints and the spare cables containing lead are indispensable (or necessary). It should be noted that a potential shift away from lead could affect the availability of repair materials, which would have an impact on the repair capability. Even if new repair materials are developed to substitute lead, a potential use of such materials would require a complete renewal of the spare parts on stock. In many cases, new extensive type tests and qualifications for spare cable and repair joints for all kinds of subsea and underground cables would be required as the repair joints are normally cable type-specific.

Furthermore, in such cases the efforts to use lead-free parts have limited benefits, considering the quantity of repair joints and spare cables is usually low in contrast to the quantity of lead in the cable being repaired.

For these reasons, lead is necessary for the efficient long-term operation and maintenance of the existing and upcoming cables. Future lead-free cables are expected to use lead-free repair materials.

4. R&D funding is necessary to accelerate lead-free developments

A substantial research and development effort is needed to develop lead free power cables. R&D cooperation and joint effort between manufacturers, TSOs and research/academia and agreement among the involved partners should take place.

The current stage of coordination between manufacturers and utilities is not sufficient to establish a clear path for the research, development, piloting, qualification and implementation of new lead-free cable products. Therefore, before subjecting the lead used in power cables to a strict authorisation processes, it is important to boost the research and development among involved parties to formulate a joint effort R&D project, taking in due consideration the value of Intellectual property rights (IPRs) and know-how for manufacturers and the need to preserve competition in the market place, along with the need to substitute internal lead sheath in power cable. In particular, it is key to make funds available for pilot projects and activities which promote collaboration, coordination and innovation in alternative technologies for new cables between TSOs and manufacturers.

Abbreviations

ECHA	European Chemical Agency
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IPR	Intellectual property rights
MI	Mass Impregnated
R&D	Research and Development
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SVHC	Substance of Very High Concern
TSO	Transmission System Operator
TYNDP	Ten-Year Network Development Plan
UK	United Kingdom

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Design

DreiDreizehn GmbH, Berlin
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Images

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Publishing date

November 2021

European Network of
Transmission System Operators
for Electricity