High Power Cable Corridors

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ABSTRACT

The integration of large amounts (e.g. offshore windfarms) renewable energies in existing HV onshore grids requires often the reinforcement or the extension of the existing grid with high power corridors. These high power corridors are essentially build with overhead lines for technical reasons. The use of underground cable systems in such corridors is limited (limited amount of cable length) for technical reasons. Different factors related to cable design and installation with specific focus on soil conditions have been examinated in order to optimise the number of parallel feeders for such high power cable corridors.

KEYWORDS

Cable, High Power, Backfill, Thermal resistivity soil, Water tables, monitoring.

INTRODUCTION

To build high power cable corridors, capable of transporting multiple GigaWatt of renewable energy, multiple EHV (400 kV) cables are needed with large conductor cross-sections, often at the limit of actual production capabilities. Besides the challenges related to the production of such cable systems, also the entire process to install such cable systems is quite challenging. Finding possible routes or trajectories to install these underground cable systems 400 kV is not always evident and the work area that is required during the construction phase is even more important, often complicating the consenting phase of the project. Special installation methods like HDD (Horizontal Directional Drillings) for the crossing of waterways, railways or highways can have a big impact (reduction) on the ampacity of the cable system.

The paper will give an overview of some investigated topics related to the design of the cable systems and parameters to be teaken into account during the installation of the cable systems (e.g. soil parameters).

Furthermore, the design of such high-power corridors must not only take into account normal grid situations but also N-1 situations and planned outages for maintenance purposes. The added value that online monitoring systems like DTS/RTTR can bring will briefly be described.

CABLE DESIGN

From cable design point, optimization can be found in reducing the AC resistance, skin and proximity effect of the cable conductors, and the reduction of the amount of reactive power (internally developed in cable and external power flows).

During the last years these parameters have already been optimized within Elia for high power cables. The use of large conductor cross-sections (2500mm²) in combination with enameled copper wires is already applied. Further increase of this conductor cross-section brings other challenges during production, transportation (weight and dimensions of the drums), and laying of these cables in area's with often limited access for large and heavy drums.

To lower the amount of reactive power developed in the cable, the thickness of the cable insulation should be increased, since the reactive power is proportional to the capacitance of the cable.

$$C = \frac{2 * \pi * \varepsilon_0 * \varepsilon_r}{\ln\left(\frac{R}{r}\right)} \quad [\frac{F}{m}]$$

For a given conductor diameter (determining r), the diameter over insulation (R) should be increased to lower the capacitance of the cable and so the reactive power.

The increase of the insulation thickness will have an impact on the final cable outer diameter, weight and price. As mentioned above, these parameters would affect the installation possibilities in Belgium.This could be avoided by shorter laying lengths and increasing the number of joints. The latter is not a preferred solution, where the aim is to reduce the number of joints as much as possible.

The use of carefully designed shunt reactor(s) on the most optimal location(s) will compensate for the reactive power flow of the cable system, increasing the active power that can be transmitted over the cable system.

CABLE INSTALLATION

Optimized backfill

Controlled or thermally optimized backfill materials have an important impact on the ampacity calculations of cable systems. These controlled backfill materials are used in trenches, both for buried cable systems as for ducted cable systems, and in Horizontal Directional Drillings (HDD's).

Elia has a long experience with the use of backfill materials, mainly for direct buried cable systems and HDD's.

For the high power corridors, investigations have been performed if these backfill materials can be improved further, both for trenches as for HDD's. The next chapters will give an overview of different tests performed, their results and conclusions.

Filler materials for Horizontal Directional Drillings (HDD)

The standard filler used so far is a bentonite mixture, with an expected thermal resistivity of 1Km/W. The filler is injected inside the inner space of the ducts used for the HDD. Special care is taken for adequate sealing of the ducts at both ends and on the points where different separate ducts are linked together. Moreover, the entire duct and high voltage cables shall withstand the fluid pressure and erosive behavior caused by the filler while injected.

Alternative materials are existing with much lower thermal