CHALLENGES IN ON-SITE PD MEASUREMENTS AND PD MONITORING ON VERY LONG HVDC 525KV EXTRUDED LAND CABLE SYSTEMS WITH RESPECT TO THE GERMAN STANDARD DIN IEC 62895:2019

Ronald **PLATH;** Technische Universität Berlin, Germany, plath@ht.tu-berlin.de

☐ **Young Researcher** (Proved full-time engineering and science university researchers and Ph.D.students under 35 YO)

ABSTRACT

For the first time worldwide, 525 kV HVDC extruded cables with lengths of up to 700 km and thousands of joints are currently being installed as part of the German energy transition. This paper deals with after-installation testing of these very long HVDC extruded land cables according to DIN IEC 62895:2019. In addition to the mandatory DC voltage testing, this standard recommends AC voltage after-installation testing of HVDC cable as well as accompanying on-site partial discharge measurements.

KEYWORDS

HVDC Cables, German Corridor Projects, After-installation AC Testing, DIN IEC 62895:2019, PD Measurement, PD Monitoring

INTRODUCTION

The energy transition in Germany requires extensive expansion of the transmission grid, especially in the north-south direction, in order to connect the increasing number of powerful offshore and onshore wind farms in the north with the load centers and growing solar power generation (currently installed capacity of about 50 GW peak) in the south. These renewable energy sources must compensate for the phase-out of the last 3 nuclear power plants (scheduled for April 15, 2023) and all fossil fuel power plants. Electric power generation from coal-fired plants will fall to zero latest by 2038. Additional challenges arise from the perspective of the "all-electric society," in which all previously fossil energy sources (e.g., transportation, heating, steel and cement production, chemical industry etc.) have to be replaced directly by electricity or by electrically generated green hydrogen. The currently still modest conversion efficiency in the electrical production of hydrogen requires large amounts of electricity, which must also be obtained from renewable energy sources.

Since additional extra-high-voltage overhead lines in Germany hardly seemed feasible against the resistance of the population ("*not in my backyard*"), the expansion of the transmission network is mainly carried out with 525 kV HVDC extruded land cables in several so-called *corridor projects*, see Fig. 1 [1].

The length of the corridor projects reaches up to 700 km, each corridor equipped with four cables (copper conductor cross section: 3000 mm^2). As is usual for land cables due to the limitations of road transport, the cable lengths respectively the distance between two joints will be about 1 km. The number of joints for just one of the corridor cables will be almost 1000, already far exceeding the total number of AC 380 kV joints installed in Europe to date.

To minimize the risk that assembly faults stay under the radar faults of mandatory IEC 62985 DC after-installation testing, the German standard DIN IEC 62895 recommends additional tests (optional) for the state-of-the-art detection of installation faults. The German TSOs already decided to follow these recommendations. The commissionings of the German corridor projects are expected for 2027/2028.

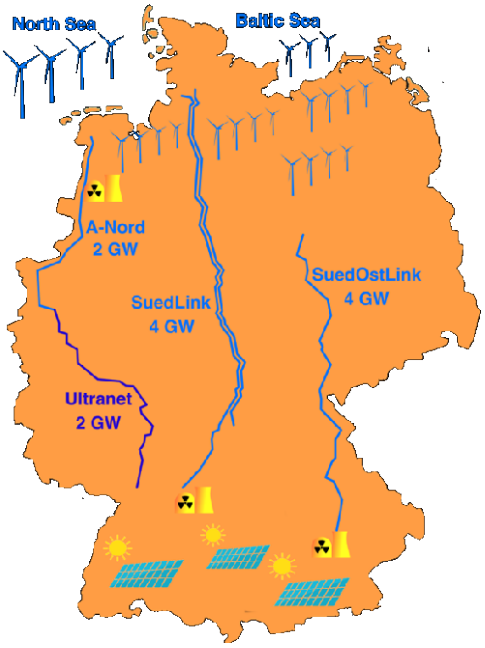

Fig. 1: German 525 kV HVDC cable corridor projects (Ultranet: overland line 400 kV HVDC)

IEC 62895:2017 AND DIN IEC 62895:2019

Within this paper, the focus is on HVDC extruded *land* cables only.

According to the international standard IEC 62895:2017, DC voltage tests for commissioning of HVDC cable systems are mandatory.

Experiences with service-aged water tree (WT) deteriorated MV AC extruded cables showed that field enhancing defects in a polymeric insulation are not reliably detected by DC voltage tests due space charge screening. Furthermore, DC voltage testing (e.g. after repair of service-aged cables) led to space charge injection, so preventing from breakdown during testing. Without precautions, direct grounding after DC testing caused travelling waves and local transient field enhancements, eventually incepting *electrical treeing* at DC charged WT structures. In such cases, these cables broke down shortly after putting back in (AC) service. These experiences finally excluded DC voltage from testing AC cables with polymeric insulation. Since long, all relevant standards require exclusively AC voltages for MV/HV AC extruded cable systems after-installation testing.