E D I T O R I A L

by Giovanni Mazzanti

Chair, DEIS Technical Committee on HVDC Cable Systems (cables, joints, and terminations)
University of Bologna, Italy

Traditionally, high voltage DC (HVDC) cable systems have been viewed as the best solution for long-distance submarine transmission links. However, and more recently, the improved performance of AC/DC converters and the environmental concerns of overhead lines have made HVDC cable transmission more and more attractive worldwide. All of this has led to a quasi-exponential growth of installed HVDC cable lines worldwide, particularly in the last two decades (see Figure 1).

In this scenario, the relatively new HVDC extruded cable systems have become more and more competitive compared with the traditional mass-impregnated, nondraining HVDC extruded cable systems, although the latter has totaled much more service experience and at voltage and power ratings up to 500 kV and 1,000 MW per bipole. But, the former has some major advantages, namely, they are much more environmentally friendly because no oil is used in the insulation, the maximum permissible conductor temperature in normal operation is higher, and splicing is much easier. Starting from the early 1980s, and largely due to extensive and sound research and development, much of which was reported in the DEIS publications, the voltage and power ratings of installed HVDC extruded cable systems have now reached the 320-kV and 1,000-MW levels. This is evident by the 320-kV-rated, cross-linked polyethylene (XLPE)–insulated HVDC cable system projects named "Sylwin 1," "Helwin 2," "Dolwin 1," "Dolwin 2," and "Dolwin 3" linking wind farms in the German North Sea to the mainland (see Figure 2) and by the 320-kV/ 2,000-MW XLPE double bipolar HVDC cable link named "INELFE" between France and Spain. In addition, the "Nemo Link," which is a 130-km-subsea and 11.5-km-land 400-kV/1,000-MW XLPE HVDC cable system, is under construction between Richborough Energy Park in Kent (UK) and Zeebrugge (Belgium).

Today, extruded insulation for DC cables does not imply XLPE as a thermoplastic extruded insulation. This new insulation, which is not crosslinked, appears to be capable of withstanding a higher temperature and a higher stress. As it is not cross-linked, manufacturing time is reduced, and the insulation is fully recyclable and therefore more environmentally friendly [1]. Furthermore, the new insulation withstands voltage polarity reversals, a situation that has forced choosing voltage source converters for all HVDC XLPE cable projects with the ex-

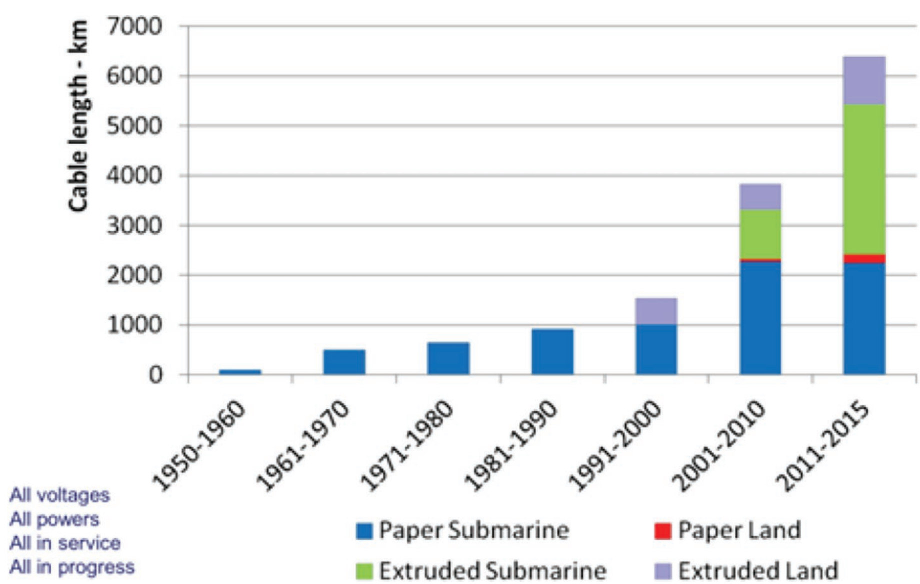

Figure 1. Cumulative length of various high voltage DC cables installed worldwide. Courtesy of Prysmian.

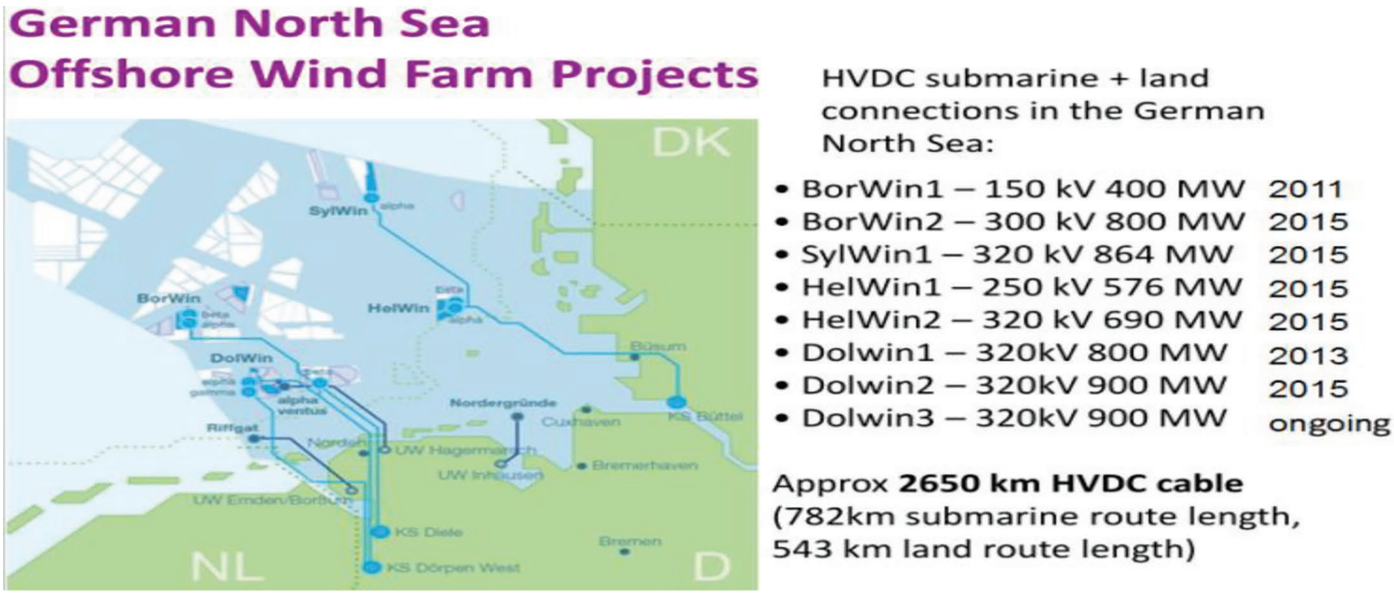

Figure 2. Major high voltage DC (HVDC) cross-linked polyethylene cables already commissioned or under completion in the German North Sea. Courtesy of Prysmian.

ception of the Hokkaido-Honshu link in Japan.

It is in this context that in 2012 the then DEIS president, Simon Rowland, asked me to form the Technical Committee (TC) titled "HVDC cable systems (cables, joints, and termination)." I must confess that I was both honored and grateful but a little intimidated about chairing this TC, but I accepted the challenge. The first meeting of the TC was in Bologna, Italy, in July 2013, at the IEEE ICSD. Since then, the TC has been very active. The first goal of the TC was to convert a protocol that was originally proposed by Massimo Marzinotto and me for measuring space charge in HVDC cables during qualification tests into an IEEE recommended practice. After a position paper was prepared on the method, IEEE Standard 1732 [2] was prepared and approved in 2016 and will be issued this year. In fact, as commented on by Paul Lewin, current president of the DEIS, the standard is the only approved IEEE standard to be developed by a DEIS TC this decade.

Now that this first task has been completed, the TC will focus on accessories, in particular on dedicated qualification tests for joints and terminations. The TC will also follow closely the developments in IEC PT 62895 "High Voltage Direct Current (HVDC) power cables with extruded insulation and their accessories for rated voltages up to 320 kV for land applications—test methods and requirements" as the extruded cable system has overcome the 320-kV barrier, with some manufacturers claiming systems up to 600 kV.

Following the proposal by the Organizing Committee of the 2016 CEIDP, a TC workshop on HVDC extruded cable systems was held at the meeting on Sunday, October 16, 2016, in Toronto, Ontario, Canada. This first workshop was intended to provide an overview of some of the major issues faced by HVDC extruded cable systems. Seven people gave presentations on the following topics:

- basics about HVDC cable transmission (G. Mazzanti);
- design of HVDC extruded cables and accessories (F. Mauseth);
- traditional (C. Reed) and innovative (T. Andritsch) extruded insulating materials for HVDC cables;
- space-charge measurements on HVDC extruded cables with PEA (T. Tanaka) and TSM (J. Castellon);
- contents and development of the above-mentioned IEEE 1732 Standard (G. Mazzanti);
- life modeling of HVDC extruded cables (G. Mazzanti); and
- life exponent in the V-t characteristic for HVDC extruded cables (K. Wu).

The workshop was a huge success, with 27 participants representing a good cross section of expertise to learn from other researchers in the field. As suggested by Ed Cherney, co-editor-in-chief of the Magazine, the presentations were compiled into articles for this issue.

References

[1] M. Albertini, A. Bareggi, L. Caimi, L. De Rai, A. Dumont, S. Franchi Bononi, G. Pozzati, and P. Boffi, "Development and high temperature qualification of innovative 320 kV DC cable with superiorly stable insulation system," in 9th Int. Conf. Insul. Power Cables (Jicable '15), 2015, paper no. A7.3, pp. 1–6.

[2] Recommended Practice for Space Charge Measurements on HVDC Extruded Cables for Rated Voltages up to 550 kV, IEEE Standard 1732, TC/WG "HVDC Cable Systems," 2017.