

Experiences and Challenges of Cable Connections of Offshore Wind Farms in the German North Sea

Volker Werle, Dr. Dongping Zhang, Dr. Jochen Jung; TenneT TSO GmbH, Germany, Asset Management Offshore, volker.werle@tennet.eu; dongping.zhang@tennet.eu; jochen.jung@tennet.eu

ABSTRACT

TenneT presents its experience in manufacturing, installation and first operation of offshore AC- and DC-connections gained during the last four years. The voltage level of DC ranges from 150 kV up to 320 kV. Cable location systems and cable failure detection has been improved, MFE has shown no adverse impact on DC-cables under voltage and low load.

KEYWORDS

XLPE cables, HVAC, HVDC, wind integration, Germany, North Sea, Energiewende, offshore TSO, offshore maintenance, fault location

INTRODUCTION

Starting in 2006 with the connection of Germany's first offshore wind farm (OWF) alpha ventus, TenneT Offshore GmbH (successing company of E.ON Netz Offshore and transpower Offshore GmbH) has been building various connections of OWF to the German grid (Fig.1). Most of the OWFs are situated far away from the coast on the continental shelf of the North Sea and all the sea cables cross the UNESCO natural reserve Wadden Sea. For spatial and efficiency reasons, HVDC has been chosen as preferred connection technology. Only two OWFs could be connected with HVAC.

By the time of this publication five HVDC grid connection systems are in test operation.

OVERVIEW OF OFFSHORE GRID CONNECTIONS

To minimize the impact on the environment and to ease the licensing procedures with the involved authorities, OWFs were connected with XLPE cables to the onshore converter station. Thus, overhead lines at the coastal areas could be avoided.

AC-Connections

It was decided to connect offshore wind farms with a distance of up to 80 km from shore directly to the grid via an AC cable connection. Up to now, two OWFs are in operation and a third one is under construction.

- alpha ventus, the first German offshore grid connection project with a voltage level of 110 kV and a capacity of 62 MW has been in continuous operation since spring 2009.
- Riffgat, the second AC-connection, faced a delay of about 13 months due to UXO (unexploded ordnance) detected along the approved cable route. In the end 30 tons of ordnance had to be recovered and cleared. The voltage level is 155 kV, the capacity is 113 MW. Riffgat is in operation since December 2013.
- Nordergründe, the third AC-connection (AC 155 kV) is under construction

DC-Connections

Nearly all OWFs are located far away from the coast (Fig. 1) on the shelf of the German North Sea, too far away to be connected via an AC-connection. Therefore, HVDC connections were installed. As the cables are crossing the UNESCO natural reserve Wadden Sea and environmental sensible land sections, XLPE cables were installed instead of well proven MI cables. This decision was mainly based on:

- Reduced cable laying costs
- Higher operation temperature
- Less weight
- Shorter installation time of accessories.

Although there has been no experience in HVDC XLPE cable technology in a voltage level higher than 150 kV in 2007, the time when the system design has been compiled. This facilitated the development of cables with a standard voltage level of 320 kV DC.



Fig. 1