

**LONG TERM TEMPERATURE MEASUREMENTS COMPARED WITH TRANSIENT CALCULATION ACC. TO IEC 60853-2**

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**ABSTRACT**

Above the cable system HelWin1 long term temperature measurements of the soil have been conducted. The results are presented and compared with calculations based on IEC-60287 and IEC 60853-2.

**KEYWORDS**

Ampacity Calculation, IEC 60287, IEC 60853-2, 2K-criteria, soil temperature measurements

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**INTRODUCTION**

Starting in 2006 with the connection of Germany's first offshore wind farm (OWF) alpha ventus, TenneT has been building various connections of OWF to the German grid (Fig.1).



**Fig1: Overview of the Offshore Grid Connections**

All grid connections are routed through the UNESCO natural reserves Schleswig-Holsteinisches Wattenmeer and/or Niedersächsisches Wattenmeer. In these areas there are strict regulations in place that control the installation of cable systems and later their operation. As the foot print of the cable systems must be as small as possible, the thermal impact on the environment is subject of a strict limitation. In the area of the Waddensea the cable system must not heat up the soil more than 2 K compared to the undisturbed soil in a depth of 30 cm below surface.

This limit has to be guaranteed twofold:

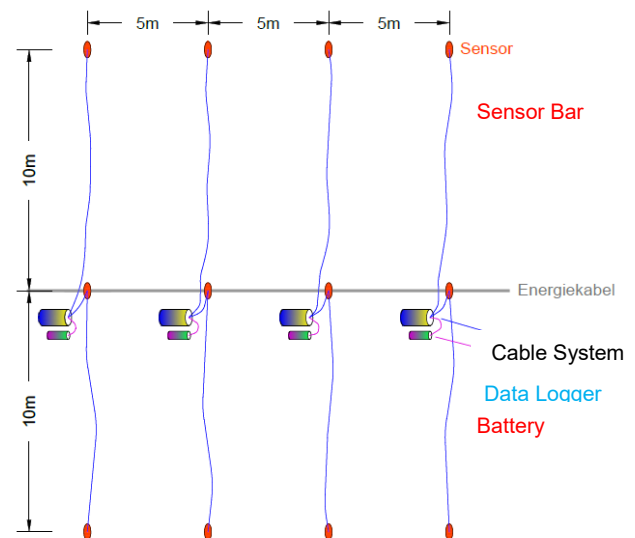
- By design calculations acc. to IEC 60287 and in particular 60853-2
- To prove the validity of the calculation a temperature monitoring must be installed due to permit requirements.

Starting end of November 2010, well before the first DC offshore grid connection system BorWin1 had been in operation, sensors have been installed over the AC cables of alpha ventus and DC cables of BorWin1.

In August 2016 a much more elaborated measurement system has been installed above HelWin1, a DC cable system that started to operate end of 2014, full OWF capacity has been installed since November 2016.

The results of the measurement campaign from August 2016 to the end of January 2018 are presented in this paper. These measurements are compared with calculations to check the validity of the applied calculation standards

**THE MEASUREMENT SYSTEM**



**Fig 2: Layout of the Sensor Array**

To compensate small local variations of the environment and to ensure a valid data basis, a total of 60 thermocouples each have been installed at two locations. The principle setup of the array is shown in Fig. 2. For each measurement above the cable system there are two measurements in 10 m distance to the cables system, in order to acquire data undisturbed from the cable system but sufficient close to minimize local variations.

The locations are near Büsum (Fig. 3), sensor array one between MP3 and MP4 and sensor array two between MP1 and MP2.