# 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. It is shown that the cables have never exceeded the maximum conductor temperature in the time period of investigation and that no trend towards higher soil temperatures is observed.

## **KEYWORDS**

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

#### INTRODUCTION

In 2006 the first German offshore wind farm (OWF) alpha ventus has been installed by TenneT and connected to shore with an AC cable system. After that, TenneT has been building many other offshore grid connection systems (GCS) up to 900 MW, especially with DC export cables. The next step is the installation of offshore GCS with a transmission capacity of 2 GW each (Fig. 1). As the cable route crosses the UNESCO natural reserve Wattenmeer the environmental authorities have placed strict regulations to limit the impact of installation and operation on the environment. One of this requirements is to limit the heating up of the soil in a depth of 30 cm below the surface by less than 2 K (known as 2K-criteria). In order to ensure that the limit is kept, the cable is designed in order to meet this criterium by means of thermal calculations according to IEC 60287 and 60853-2. To verify these calculations, in situ measurements have been performed for different GCS starting in 2010. Due to limitations of the measurement systems and low utilizations of the investigated GCS, a new state of the art temperature measurement system was installed in August 2016 for the HelWin1 GCS.



# Fig. 1: Overview of present and future offhsore GCS of TTG in Germany

The temperature sensors have been installes above the DC cable of HelWin1 in the Waddensea section (near the shore of Büsum). First results of the measuring period from 2016 to 2018 have been presented in the past [1]. The measured values were also compared with temperature calculations. It was shown that the temperature calculations always overestimated the measurements and that the 2K criterion was not exceeded during the period under consideration (2016 to 2018). The environmental impact at the 2K depth level has been significantly higher than the heating of the cable.

This paper is intended to serve as an update, spanning the time period of 6 years (2016-2022) in order to see possible long term trends during operation of the GCS.

## THE MEASUREMENT SYSTEM

To compensate small local variations of the environment and to ensure a valid data basis, a total of 60 thermocouples 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 north and sourth to the cables system, in order to acquire data undisturbed from the cable system but sufficiently close to minimize local