# Experience with the commissioning and operation of a monitoring system on a 380 kV cable system in Belgium

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## *ABSTRACT*

*In the paper, the experience and knowledge gained through the design, installation and commissioning of a partial discharge monitoring (PDM) system on a 10 km underground, 380 kV AC cable line are presented. The PDM system monitors the condition of the entire cable and all of its accessories in real time and the system simultaneously performs measurement of the cable shield current as well as the condition of sheath voltage limiters. The paper describes the hardware and software technologies associated with the partial discharge acquisition unit and the power supply solution used in the PDM. A separate chapter is dedicated to the procedure used for site acceptance testing of the PDM. Initial user experience after 1.5 years using the PDM system, including its extra functionalities, is also presented in the paper.*

## *KEYWORDS*

HV Cable, Condition Based Maintenance, Partial Discharge Measurements, Testing and Monitoring

## INTRODUCTION

In 2016-2017, Elia built a new 380 kV high-voltage (HV) link between Zomergem and Zeebrugge, over a total distance of 47 km. This endeavor is called the Stevin project. About 10 km of the HV link is executed in underground cables, the rest as overhead lines. The underground part consists of 4 circuits, each with 3 380 kV 2500 mm² CuEM HV cables from two different cable manufacturers, with cross-bonding and 12 minor sections [1]. This configuration is designed to transport 3000 MVA (in N-1) of power. Each HV cable is capable of transporting 1000 MVA, so in the case of a failure in one of the cable systems, the remaining three systems can transport the requested power of 3000 MVA (Figure 1).

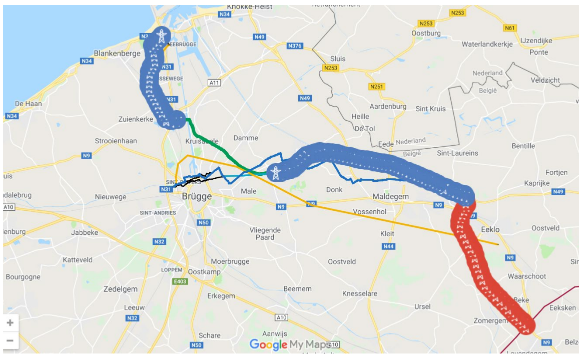

**Fig. 1: Location of Stevin project**

Since this HV cable system is critical for the Belgian Grid, accurate monitoring of its insulation condition is necessary. In 2016-2017, a complete partial discharge (PD) monitoring system was designed and installed. This monitoring application is designed to detect, evaluate and locate possible partial discharges during the site acceptance test and during the operation of this 380 kV cable system.

The following aspects will be particularly addressed in this paper: sensor positioning and type testing of the link box, power supply for monitoring system installed at buried cables, defect localization, and monitoring of additional parameters (Figure 2).

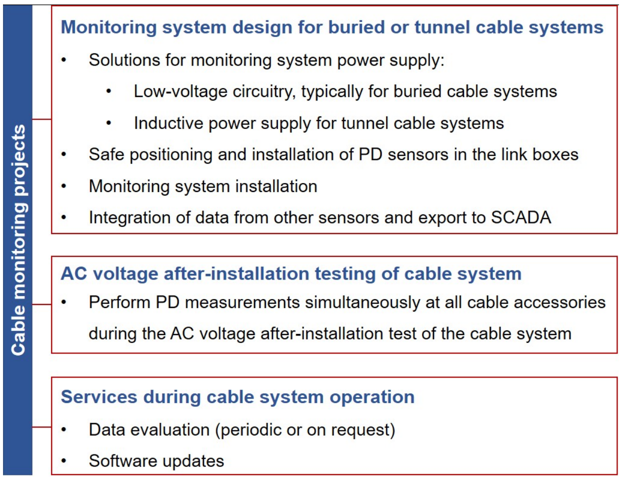


**Fig. 2: Challenges during the design, installation and operation of a cable monitoring system.**

In addition to continuously checking on the condition of the HV cable, joints and terminations, extra functionalities are integrated to reduce and/or replace future preventive maintenance activities. Information about the total harmonic distortion (THD) of the HFCT sensors enables the 50 Hz induced current in the screens to be calculated. An abnormal change of this current is related to the incorrect functionality of the cross-bonding system, which is possibly caused by a direct contact between cable screen/SVL and the earth. An additional HFCT sensor, installed on the earth conductors in the cross-bonding boxes, detects the SVL status (open, short-circuit) in the cross-bonding boxes.

## DESIGN AND INSTALLATION OF THE PDM SYSTEM

The PD cable monitoring system consists of 156 high-frequency current transformers (HFCT) for the detection of PD and 52 data acquisition units (AU) connected via daisy chain to a data concentration unit in the substation. The sensors of the PD monitoring system are permanently installed at each of the 24 terminations and 132 joints along these buried HV cable circuits (Figure 3). The sensors continuously measure PD activity and the insulation condition in the HV cables and cable accessories.