



Optical Fault Location and Temperature Monitoring of a 220 kV Power Cable

Denmark

The “Horns Rev 3” offshore wind farm, located off the west coast of Denmark, has a maximum installed power capacity of 400 MW. The operators wanted a monitoring solution to locate cable faults immediately after they occur. They chose AP Sensing for our unique combination of DTS (Distributed Temperature Sensing) and DAS (Distributed Acoustic Sensing) capabilities.

The project:

Horns Rev 3 is Denmark’s 3rd offshore wind farm (OWF). The project consists of:

- An offshore transformer platform
- A 220 kV offshore power cable from the platform to the transition joint located onshore and then to the substation Blåbjerg (36 km)
- A 220 kV underground land cable from the substation Blåbjerg to the substation Endrup (45 km).

The sensor cables:

- Loose tube fiber optical cable with 4x12 G.652D single mode fibers and 1x6 OM3 multimode fibers.
- At the subsea section, the sensor cable is located inside the three phase subsea cable, which is buried 1 m below the seabed.
- At the land section, the sensor cable is located in a Ø40 tube close to the center single phase cable, which is buried 1.4 m below the surface.



Off- and onshore power cable routing

Units:

- The optical fault location system is based on DAS (Distributed Acoustic Sensing) technology. The DAS system detects acoustic signals that may be generated by a fault in or near the high-voltage cable. The vibrations that are produced by a fault are impulsive, broad in distance, and occur typically in the low-frequency range.
- The DAS system is configured to monitor the power cable in real-time, visualize the acoustic energy over time/distance in waterfall plots, and store the measured data. The system is additionally configured to alarm fault events and visualize the alarms in SmartVision.
- The optical fault location system consists of 3 DAS systems, including a single-channel DAS interrogator, a DAS data acquisition unit, and a storage unit each:
 - 2 DAS units in Blåbjerg: 1 channel, 40 km measurement range (N5000A).
 - 1 DAS unit in Endrup: 1 channel, 40 km measurement range (N5000A).
- The temperature monitoring system consists of 2 DTS units:
 - 1 DTS unit in Blåbjerg: 2 channels, 40 km measurement range (N4415A).
 - 1 DTS unit in Endrup: 4 channels, 30 km measurement range.

The free channels are allocated for upcoming projects (N4415A).



The AP Sensing Distributed Acoustic Sensing and Linear Power Series instruments



Underground cable route inspection

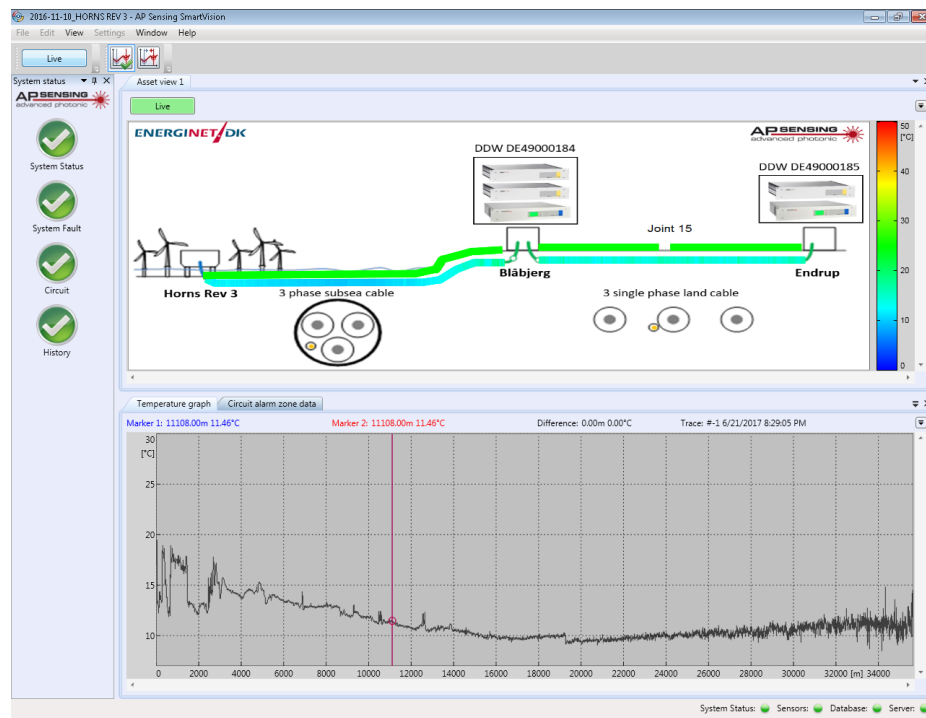
SmartVision™ Asset Visualization:

AP Sensing's proprietary asset visualization software, SmartVision™, provides multiple operators at multiple locations with a graphic overview of all temperature and acoustic information.

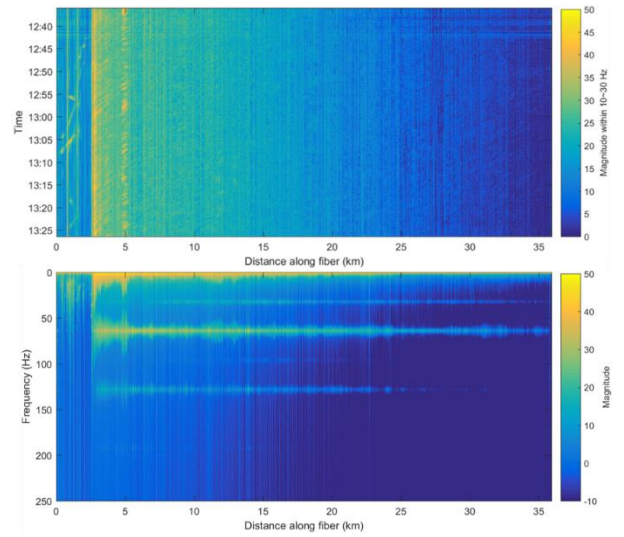
The main user interface for SmartVision™ is located at the Endrup substation. The software tool collects the temperature data in real time from the two temperature sensing devices and the alarms from the three acoustic sensing devices, providing the user a combined overview of both systems.

Using the IEC-60870-5-104 protocol, SmartVision accesses the client's SCADA/DCS platform to retrieve and share system and alarm status information.

Using the SmartVision Supervisor functionality installed on the main server at Energinet's head office, operators can also switch between different projects integrated by AP Sensing.



The SmartVision™ Graphical User Interface (GUI)



Fully integrated rack solution with DTS, DAS and SmartVision™ in the control room

Ready for future growth:

AP Sensing's experienced Project Engineering team accompanied both pre-energizing test phases of the land and subsea power cable sections.

The entire system has performed as expected since the completion of the installation and plans are underway for future projects.

