The challenge

Responsible for the power networks in Guangdong, Guangxi, Yunnan, Guizhou and Hainan provinces, China Southern Power Grid Co. (CSG) operates one of the largest, most complicated power grids in the world. It serves 230 million people, has an installed generation capacity of 160 GW (2010) and a peak load of 105 GW. Being a hybrid HVAC and HVDC grid makes secure and reliable operation particularly challenging.

Located on China’s southern coast, Hainan Island is separated from mainland China by the shallow, narrow Qiongzhou strait. To support the island’s economic development, a 32 km AC subsea interconnector was proposed between LinShi Island (Hainan province) and NanLing (Guangdong province) to integrate it into the CSG grid.

Nexans, was awarded the contract to provide the 500 kV submarine link. The project consisted of three single-core oil-filled cables configured as a three-phase AC power cable system, installed in a trench. The initial power capacity is 600 MW, with the potential to expand as the island develops.

The interconnector is subjected to strong tidal currents, the effects of typhoons and seabed migration around the shore crossings. In addition, dropped objects, anchors and fishing pose constant threats to the submarine cables, whose construction ensures robustness and longevity. The highest performance cable monitoring was specified; one powerful enough to monitor continuously condition along the length of the three cables between LinShi and NanLing and accurate enough to provide the temperature input for the Nexans Dynamic Rating System (DRS).
The energy cable monitoring solution

Omnisens was contracted to install its DITEST-LTM fiber optic distributed temperature sensing system, to monitor continuously the temperature along the complete length of the three subsea cables. The DITEST is based on stimulated Brillouin sensing, which is frequency rather than intensity based. This provides long distance monitoring ability with superior accuracy and stability of measurement over even the longest range.

The system provides continuous monitoring to provide early warning of hotspots, which could indicate a breakdown in insulation or a change in the operating environment of the cable, leading to a potential overload. The precise location of the problem can be instantly pinpointed to within a one meter section of the cable. Knowing these, the operator can take rapid action to reduce power throughput and prevent an outage, while the problem is investigated.

In addition, the Omnisens DITEST-LTM provides real time temperature data to the dynamic rating system (DRS) allowing the operator to optimize power transmission according to measured rather than estimated cable data.

Configured for automatic and permanent monitoring, the system includes a dedicated server which provides data storage and the interface to the DRS, which is housed at the substation at FuShan. The monitoring system design, with two DITESTs, (one situated in NanLing, the other in LinShi) each with three channels and communicating with their “own” DRS, offers full redundancy.

Results

The Omnisens DITEST helps secure the supply of electricity to Hainan Province and its popular island holiday destinations.

To do this, the Omnisens DITEST provides:

- Condition monitoring. The system alerts operators to anything that indicates a breakdown in insulation or a change in the operating environment of the cable which may result in an overload, with user-defined alarms and status messages sent to the DRS using Modbus TCP/IP protocol via Ethernet.

- Dynamic Rating System input. The cable load capacity is calculated from component temperature and environmental conditions, rather than assumptions. The temperature at each point along the cable is sent every few minutes (user defined) to the Dynamic Rating System (DRS) using web based communication via TCP/IP using a closed, private optical Ethernet datacom network. A thermal transfer model for the HV cables takes the temperature profile from the DITEST and uses the current and voltage values from the remote terminal unit to calculate the copper core temperature. The load of the cable can thus be optimized.