

Superconducting Technologies for Smart Grids

Smart Grid, Green Innovation

The superconducting technologies that Furukawa Electric possesses are likely to offer excellent solutions to environmental and energy issues.

Feature of smart grid

- 1 High-efficiency
HTS (high-Tc superconducting) power cable, HTS DC cable
- 2 High reliability, self-resilience
Real time monitor, advanced control system, FCL (fault current limiter)
- 3 High quality
Power storage system, high voltage power device, FCL
- 4 Dispersed power source

Superconductivity

Superconductivity is a phenomenon occurring in certain materials at very low temperatures. It was discovered by Heike Kamerlingh Onnes in 1911. High Tc superconductors, which operate in liquid nitrogen temperatures, are promising HTS applications including power storage, transformers, power storage, fault current limiters in power systems, and are expected to use electricity as in-vehicle propulsion.

SMES

Electrical power storage device



HTS power cable

Low loss and compact power transmission cable



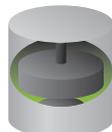
DC HTS cable

Long-distance transmission cable



Fly wheel

Electrical power storage device



FCL

Fault current limiter for short circuit accident

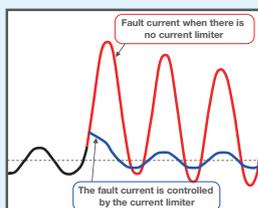


A fault current limiter (FCL) that uses superconducting materials is a power device that suppresses fault currents.

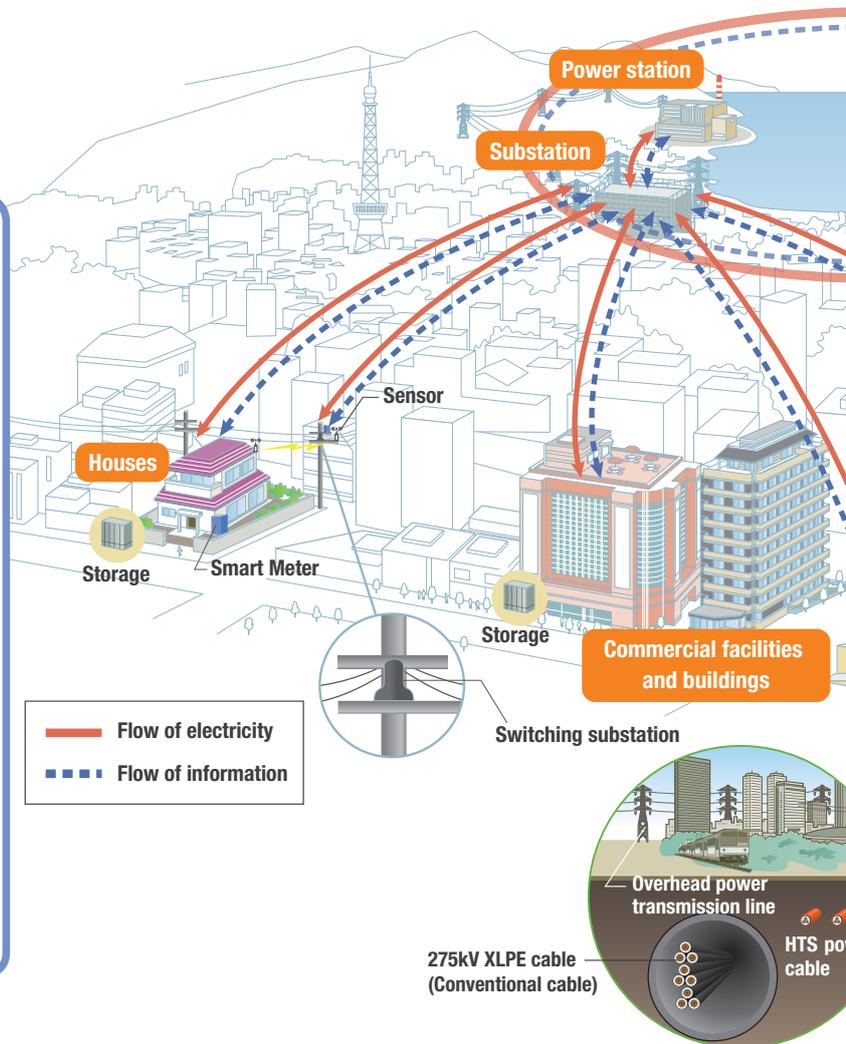
FCL will be an essential element in the smart grid, maintaining its reliability and improving its resilience and flexibility.

Features

- High-speed circuit break
- Self-restitution



6.6kV 200A class FCL system

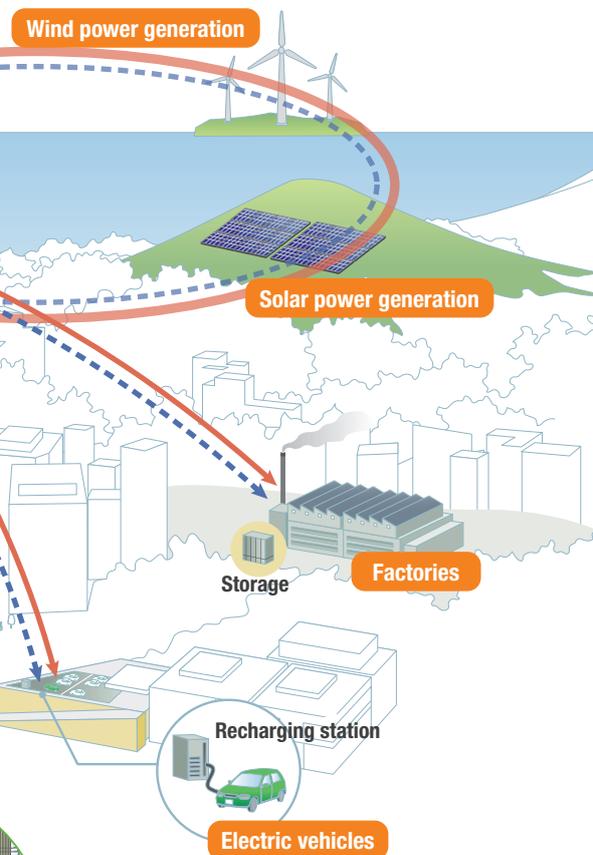


an electrical resistance of exactly zero, materials below a characteristic temperature. Like Kamerlingh Onnes in 1911. HTS, which has superconducting properties at a higher temperature, was discovered in 1986. The many applications include electric power transmission, energy storage devices, electrical generators, and motors, and a high-performance smart grid. HTS is also used in electric motors and magnetic levitation devices, such as ship propulsion, and Maglev trains.



HTS wind generator

Low loss and compact wind generator



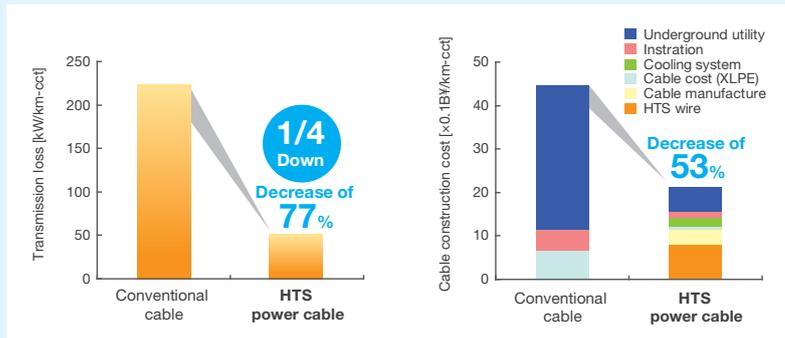
Superconducting power cable

The transmission cables of the future are likely to be HTS power cables rather than conventional cables.

Advantage of HTS power cable

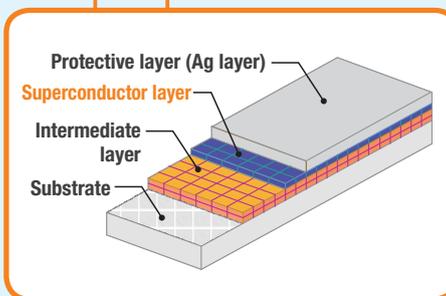
- Compact
- Large transmission capacity
- Low transmission loss
- EMI suppression by an HTS shield

A high-T_c superconducting power cable (HTS power cable) will provide a 1/4 reduction in transmission loss between power plants and users compared to conventional cables using copper or aluminum.



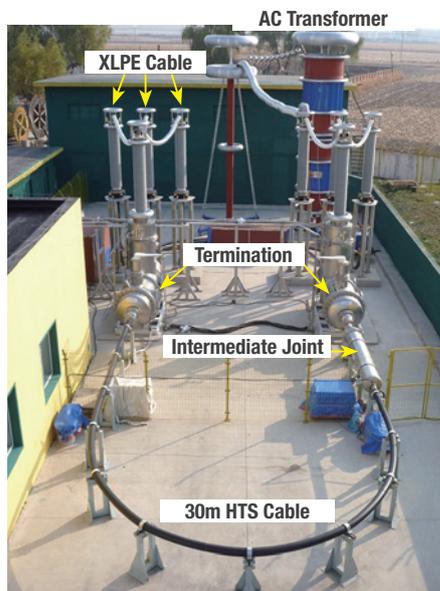
275kV HTS power cable

66kV HTS power cable



YBCO tape

YBCO is a crystalline chemical compound with the formula $\text{YBa}_2\text{Cu}_3\text{O}_7$. This material, a renowned "high-temperature superconductor," achieved prominence because it was the first material to achieve superconductivity above the boiling point of nitrogen.



Demonstration of 275kV-3kA HTS power cable

- The 275kV-3kA HTS power cable using YBCO tapes has the world's largest capacity of 1.5GW, which is about the same as overhead lines.
- The 30m cable demonstration was conducted in the NEDO project. The cable system was constructed in Shenyang Furukawa Cable Co., Ltd. in China at 2012.
- The test layout included the 30m HTS cable, two terminations, an intermediate joint, and three XLPE cables, that were used for the flowing current of 3kA.

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