



## **HVDC: technology for energy efficiency and grid reliability**

**Since power sources are rarely near the places that need power, classic high voltage direct current (HVDC) is an excellent technology for transmitting large amounts of electricity over hundreds or even thousands of kilometers to where it is needed most, with much lower losses than a power link of corresponding size carrying alternating current (AC).**

A 2,000-km long HVDC line rated at 800 kilovolts loses about 5 percent of the electricity it carries to heat, while an equivalent AC line would lose twice that amount, or about 10 percent.

Long-distance DC transmission also uses less space: a 2,000-km DC link rated at 6,000-megawatts needs just one power line, versus three lines for an AC link of equivalent power and length.

High efficiency transmission technology will play a central role in the development of renewable power sources in remote areas, including solar projects in the Sahara.

### **Cost benefits**

To transmit electrical power as DC, alternating current generated at a power plant is converted into DC power at a special station. At the other end of the transmission line, the DC power is converted back into AC electricity that can be used by consumers. The cost benefit of DC over AC transmission is apparent over long distances, (typically more than 600 km for overhead lines, and more than 50 km for underground or underwater cables).

As well as increasing long-distance transmission efficiency, power flow in a DC line can be precisely controlled, stabilizing the transmission network and preventing the cascading outages that can lead to widespread blackouts.

HVDC technology is also used to connect asynchronous (incompatible) AC power networks, increasing the efficiency and stability of each. The HVDC stations described above convert the electricity so that it can flow in either direction, which means adjacent power networks can effectively match electrical supply and demand.

ABB developed HVDC and delivered the first commercial HVDC link in 1954. In the intervening 50 years, HVDC technology has advanced significantly thanks to developments in new materials used by the two enabling technologies: power semiconductors and transmission cables.

The new 580-kilometer NorNed HVDC connection between the grids of Norway and the Netherlands is the world's longest underwater power link. It will provide greater access to Norway's clean hydro energy, and help save an estimated 1.7 million tons of carbon dioxide emissions every year simply by reducing the output of fossil-fuelled power plants in the area.



## **HVDC Light**

A significant milestone in the history of HVDC was achieved in the 1990s with ABB's development of HVDC Light.

The technology offers the same benefits as traditional HVDC, and in addition provides more secure power control and quick power restoration in the event of a blackout. It can compensate for fluctuations in power levels, making it an ideal technology for stabilizing irregular electricity flows, such as those generated by wind farms, which can potentially disrupt power networks.

HVDC Light is environmentally friendly, featuring oil-free cables, compact converter stations and cables that can be laid underground as well as underwater. It is the only technology currently available that allows long-distance high-voltage transmission underground, as of today up to 1,200 megawatts.

Benchmark ABB installations using HVDC Light include the world's longest underground high-voltage interconnection, running 177 km between the Australian states of Victoria and South Australia, and the Cross Sound Cable linking Connecticut and Long Island in the U.S., which was used to help restore power to the region following the widespread blackouts in 2003.

ABB in 2005 delivered the world's first HVDC Light link to an offshore oil and gas platform. The supply of emissions-free hydropower from the Norwegian mainland enabled Norway's Statoil to avoid using diesel generators on the rig, which would have produced about 230,000 tons of carbon dioxide emissions annually. ABB is building a similar connection from the Norwegian mainland to BP's Valhall platform in the North Sea.

## **Ultrahigh voltage**

The development of ultrahigh-voltage direct current (UHVDC) technology has provided the biggest leap in capacity and efficiency leap in HVDC transmissions in 20 years. It transmits electricity at 800 kilovolts (kV), compared with 600 kV on the highest-voltage power line in the world today, built by ABB at Itaipu in Brazil in 1987.

UHVDC is particularly suited to vast countries, where industrial and residential centers are far away from the sources of power. ABB is supplying ultrahigh-voltage technology for the world's longest power link, a 2,000-kilometer power line in China. At 6,400 megawatts, the transmission line's power rating is also more than double the most powerful rating in operation today, creating a power superhighway to support economic growth in China.

## **Leading supplier**

ABB has supplied more than half of the HVDC converter stations in the world and has more than 50 HVDC projects either commissioned or under construction.

In northern Europe, there are already a number of ABB-built HVDC interconnections. They include links between Sweden and Denmark; Norway and Denmark; Sweden and Germany; Denmark and Germany; Sweden, Poland and Germany; and Sweden and Finland.