HIGH VOLTAGE DIRECT CURRENT - HVDC

HVDC or high-voltage, direct current electric power transmission systems contrast with the more commonalternating-current systems as a means for the bulk transmission of electrical power. The modern form of HVDC transmission uses technology developed extensively in the 1930s in Sweden at ASEA. Early commercial installations include one in the USSR in 1951 between Moscow and Kashira, and a 10-20 MW system in Gotland, Sweden in 1954[1].

Advantages of high voltage transmission

Early electric power distribution schemes used direct-current generators located near the customer's loads. As electric power became more widespread, the distances between loads and generating plant increased. Since the flow of current through the distribution wires resulted in a voltage drop, it became difficult to regulate the voltage at the distribution circuit extremities.

Higher voltages reduce the transmission power loss or reduce the cost of conductors when transmitting a given quantity of power since a smaller current is required. Conductor cost is roughly proportional to the current carried, and conductor loss is roughly proportional to the square of the current, so higher transmission voltages improve the efficiency of transmission.

Low voltage is convenient for customer loads such as lamps and motors. The principal advantage of AC is that it allows the use of transformers to change the voltage at which power is used. No equivalent of the transformer exists for direct current, so the manipulation of DC voltages is considerably more complex. With the development of efficient AC machines, such as the induction motor, AC transmission and utilization became the norm (see War of Currents).

History of HVDC transmission

An early method of high-voltage DC transmission was developed by the Swiss engineer Rene Thury [2]. This system used series-connected motor-generator sets to increase voltage. Each set was insulated from ground and driven by insulated shafts from a prime mover. An early example of this system was installed in 1889 inItaly by the Society Acquedotto de Ferrari-Gallieri. This system transmitted 630 kW at 14 kV DC over a distance of 120 km[3]. Other Thury systems operating at up to 100 kV dc operated up until the 1930s, but the rotating machinery required high maintenance and had high energy loss. Various other electromechanical devices were tested during the first half of the 20th century with little commercial success[4].

The grid controlled mercury arc valve became available for power transmission during the period 1920 to 1940. In 1941 a 60 MW, +/- 200 kV, 115 km buried cable link was designed for the city of Berlin using mercury arc valves (Elbe-Project), but owing to the collapse of the German government in 1945 the project was never completed[5]. The nominal justification for the project was that, during wartime, a buried cable would be less conspicuous as a bombing target. The equipment was moved to the Soviet Union and was put into service there [6].

Introduction of the fully-static mercury arc valve to commercial service in 1954 marked the beginning of the modern era of HVDC transmission. Mercury arc valves were common in systems designed up to 1975, but since then, HVDC systems use only solid-state devices.

Advantages of HVDC over AC Transmission

In a number of applications HVDC is often the preferred option.

Undersea cables. (e.g. 250 km Baltic Cable between Sweden[[7]] and Germany[[8]].

Endpoint-to-endpoint long-haul bulk power transmission without intermediate 'taps', for example, in remote areas.

Increasing the capacity of an existing power grid in situations where additional wires are difficult or expensive to install.

Allowing power transmission between unsynchronised AC distribution systems.

Reducing the profile of wiring and pylons for a given power transmission capacity.

Connection of remote generating plant to the distribution grid, for example Nelson River Bipole.

Stabilising a predominantly AC power-grid,without increasing maximum prospective short circuit current.

Long undersea cables have a high capacitance. While this has minimal effect for DC transmission, the current required to charge and discharge the capacitance of the cable causes additional I^2R power losses when the cable is carrying AC. In addition, AC power is lost to dielectric losses.

HVDC can carry more power per conductor, because for a given power rating the constant voltage in a DC line is lower than the peak voltage in an AC line. This voltage determines the insulation thickness and conductor spacing. This allows existing transmission line corridors to be used to carry more power into an area of high power consumption, which can lower costs.

Increased stability of power systems

Because HVDC allows power transmission between unsynchronised AC distribution systems, it can help increase system stability, by preventing cascading failures from propagating from one part to another of a wider power transmission grid, whilst still allowing power to be imported or exported in the event of smaller failures. This has caused many power system operators to contemplate wider use of HVDC technology for its stability benefits alone.

Possible health advantages of HVDC over AC transmission

A high-voltage DC transmission line would not produce the same sort of extremely low frequency (ELF) electromagnetic field as would an equivalent AC line. It is speculated by those who believe that ELF radiation is harmful that such a reduction in EM fields would be beneficial to health. The benefits would extend only to those near the transmission lines, as the electric and magnetic fields associated with high current AC transmission lines do not travel far beyond the actual lines themselves. These fields are, however, also associated with electrical equipment and household appliances. It should be noted that the current scientific consensus[7] does not consider ELF sources and their associated fields to be particularly harmful, and that deployment of HVDC equipment would not completely eliminate electric fields, as there would still be DC electric field gradients between the conductors and ground.

Disadvantages

The required static invertors are expensive and cannot be overloaded very much. At smaller transmission distances the losses in the static inverters may be bigger than in an AC powerline, and the cost of the inverters may not be offset by reductions in line construction cost.

In contrast to AC systems, realizing multiterminal systems is complex, as is expanding existing schemes to multiterminal systems. Controlling power flow in a multiterminal DC system requires good communication between all the terminals.

Source : http://engineering.wikia.com/wiki/HVDC