ELECTRIC POWER TRANSMISSION

Electric power transmission is one process in the delivery of electricity to consumers. It refers to the 'bulk' transfer of electrical power from place to place.

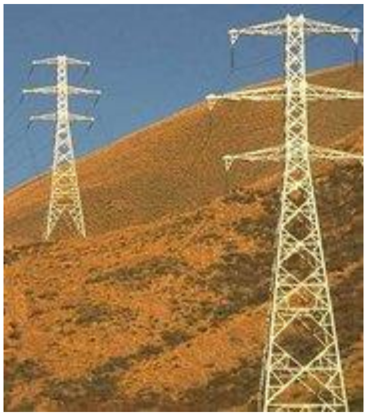
Transmission lines in Lund,Sweden

Description

Typically power transmission is between the power plant and a substation in the vicinity of a populated area. This is distinct from electricity distribution which is concerned with the delivery from the substation to the consumers. Due to the large amount of power involved, transmission normally takes place at high voltage (110 kV or above). Electricity is usually sent over long distance through overhead power transmission lines (such as those in the photo on the right). Power is transmitted underground in densly populated areas (such as large cities) but is typically avoided due to the high capacitive and resistive losses incurred.

A power transmission system is sometimes referred to colloquially as a "grid". However, for reasons of economy, the network is rarely a grid (a fully connected network) in the mathematical sense. Redundant paths and lines are provided so that power can be routed from any power plant to any load center, through a variety of routes, based on the economics of the transmission path and the cost of power. Much analysis is done by transmission companies to determine the maximum reliable capacity of each line, which, due to system stability considerations, may be less than the physical limit of the line. Deregulation of electricity companies in many countries has lead to renewed interest in reliable economic design of transmission networks. The separation of transmission and generation functions is one of the factors that contributed to the 2003 North America blackout.

AC power transmission



Transmission towers in the New Zealand countryside

AC power transmission is the transmission of electric power by alternating current. Usually transmission lines use three phase AC current. In electricrailways, sometimes single phase AC current is used as traction current for railway traction.

Today, transmission-level voltages are usually considered to be 110 kV and above. Lower voltages such as 66 kV and 33 kV are usually considered sub-transmission voltages but are occasionally used on long lines with light loads. Voltages less than 33 kV are usually used for distribution. Voltages above 230 kV are considered extra high voltage and require different designs compared to equipment used at lower voltages.

Bulk power transmission

A transmission grid is a network of power stations, transmission circuits, and substations. Energy is usually transmitted within the grid with 3-phase alternating current (AC).

The capital cost of electric power stations is so high, and electric demand is so variable, that it is often cheaper to import some portion of the variable load than to generate it locally. Because nearby loads are often correlated (hot weather in the Southwest portion of the United States[[1]] might cause many people there to turn on their air conditioners), imported electricity must often come from far away. Because of the irresistible economics of load balancing, transmission grids now span across countries and even large portions of continents. The web of interconnections between power producers and consumers ensures that power can flow even if one link is disabled.

Long-distance transmission of electricity is almost always more expensive than the transportation of the fuels used to make that electricity. As a result, there is economic pressure to locate fuel-burning power plants near the population centers that they serve. The obvious exceptions are hydroelectric turbines -- high-pressure water-filled pipes being more expensive than electric wires. The unvarying portion of the electric demand is known as the "base load", and is generally served best by facilities with low variable costs but high fixed costs, like nuclear or large coal-fired powerplants.

Grid input

At the generating plants the energy is produced at a relatively low voltage of up to 25 kV (Grigsby, 2001, p. 4-4), then stepped up by the power station transformer to a higher voltage for transmission over long distances to grid exit points (substations).

Losses

It is necessary to transmit the electricity at high voltage to reduce the percentage of energy lost. For a given amount of power transmitted, a higher voltage reduces the current and thus the resistive losses in the conductor. Long distance transmission is typically done with overhead lines at voltages of 110 to 765 kV. However, at extremely high voltages, more than 2 million volts between conductor and ground, corona discharge losses are so large as to offset the advantage of lower heating loss in the line conductors.

Transmission and distribution losses in the USA were estimated at 7.2% in 1995 [2], and in the UK at 7.4% in1998. [3]

In an alternating current transmission line, the inductance and capacitance of the line conductors can be significant. The currents that flow in these components of transmission line impedance constitute reactive power, which transmits no energy to the load. Reactive current flow causes extra losses in the transmission circuit. The fraction of total energy flow (power) which is resistive (as opposed to reactive) power is the power factor. Utilities add capacitor banks and other components throughout the system—such as phase-shiftingtransformers, static VAr compensators, and flexible AC transmission systems (FACTS)—to control reactive power flow for reduction of losses and stabilization of system voltage.

HVDC

High voltage DC (HVDC) is used to transmit large amounts of power over long distances or for interconnections between asynchronous grids. When electrical energy is required to be transmitted over very long distances, it can be more economical to transmit using direct current instead of alternating current. For a long transmission line, the value of the smaller losses, and reduced construction cost of a DC line, can offset the additional cost of converter stations at each end of the line. Also, at high AC voltages significant amounts of energy are lost due to corona discharge, the capacitance between phases or, in the case of buried cables, between phases and the soil or water in which the cable is buried. Since the power flow through an HVDC link is directly controllable, HVDC links are sometimes used within a grid to stabilize the grid against control problems with the AC energy flow. One prominent example of such a transmission line is the Pacific Intertielocated in the Western United States.

Grid exit

At the substations, transformers are again used to step the voltage down to a lower voltage for distribution to commercial and residential users. This distribution is accomplished with a combination of sub-transmission (33 kV to 115 kV, varying by country and customer requirements) and distribution (3.3 to 25 kV). Finally, at the point of use, the energy is transformed to low voltage (100 to 600 V, varying by country and customer requirements).

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