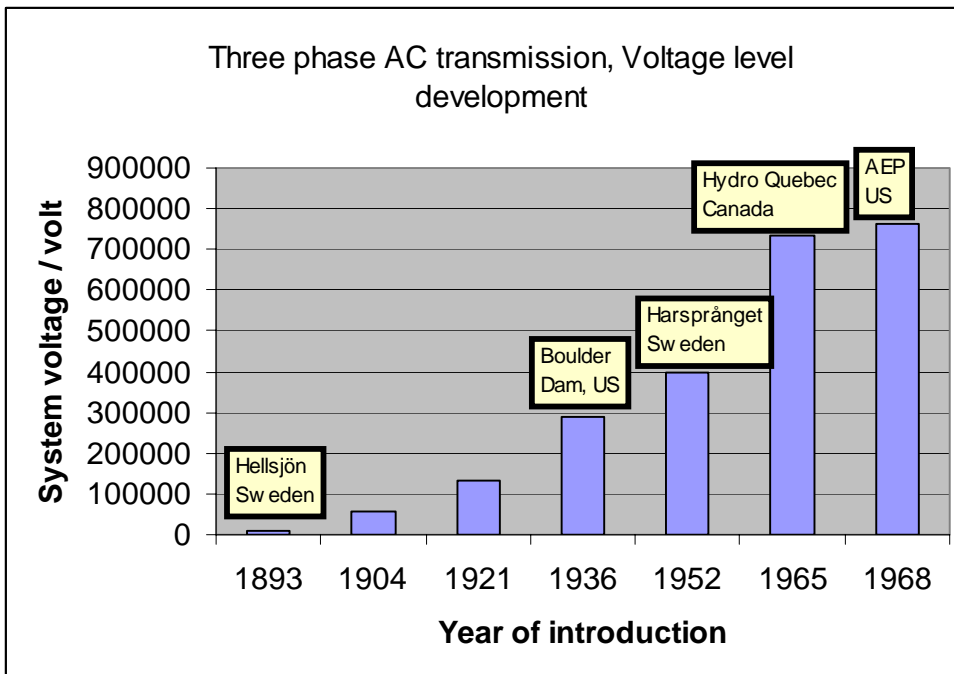


## The history of HVDC transmission

### *Power transmission in general*

During the latter part of the 19th century, electricity started to become increasingly important for society. In 1879, Edison invented the filament lamp and a few years later three-phase alternating current was introduced simultaneously at several places across the world. One of these was Hellsjön near Ludvika in Sweden, where ASEA (as ABB was then known) built one of the world's first transmission links.

Since then, three-phase alternating current has been the dominant option for the transmission of electric power over long distances. Figure 1 shows how developments led to higher voltages, increasing the scope for the transmission of more power over greater distances.



Since the introduction of 765 kilovolts (kV) in 1968 there has been no further increase in the transmission voltage used for commercial systems. A number of trial lines operating at 1,000 and 1,200 kV have been built, but up to now the decision has been to stay with 765 kV as the highest voltage.

The amount of power transmitted over the alternating current systems supplied increased accordingly. For AC systems, however, the transmitted power is limited by reliability and voltage stability requirements. Today, the normal capacity is 600 megawatts (MW) for 400 kV links and 2,000 MW for 765 kV systems.

A normal AC transmission system operating at 400 kV and above generally has switchyards at sites where power needs to be drawn off or fed into the system. The equipment in such switchyards includes transformers to raise the voltage. On long transmission lines (more than 300 km) it is normal practice to install capacitors along the line to maintain the voltage and reduce losses.

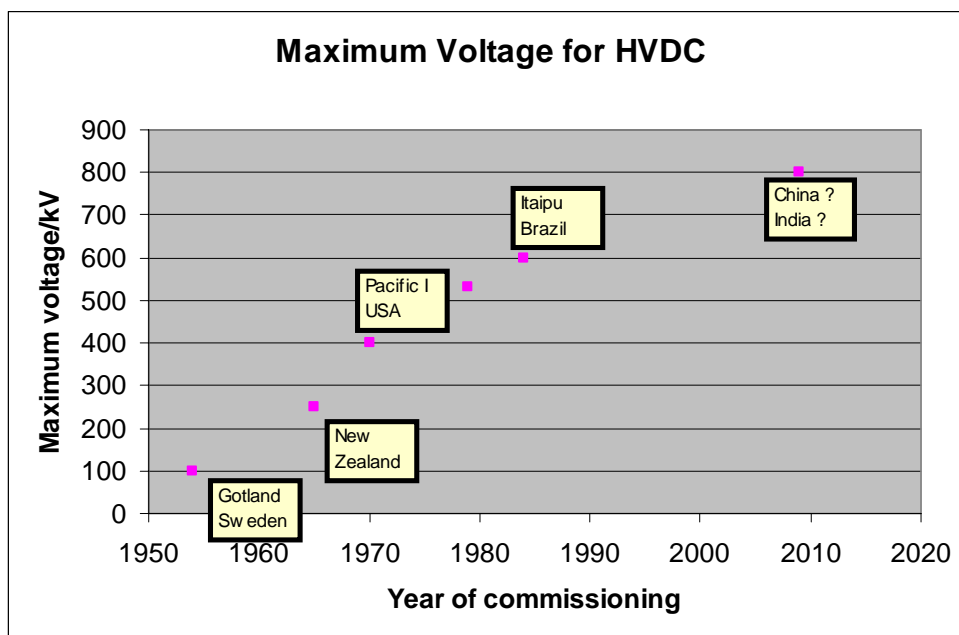
## DC voltage

The development of high-voltage direct-current (HVDC) for power transmission purposes began in the mid 1920s. The first commercial HVDC link, delivered by ASEA in 1954, carried power between the mainland of Sweden and the island of Gotland.

There are a number of differences between AC and DC:

- Line losses are significantly lower for DC. For a 2,000-kilometer (1,240 miles) link, line losses for 800 kV DC are about 5 percent, while the corresponding losses for 765 kV AC are double, at about 10 percent.
- For the transmission of comparable amounts of power, the cost of a power line is lower for DC. A 2,000 km HVDC transmission line rated at 6,000 MW needs **one** power line with **two** suspended conductors. An equivalent AC link operating at 765 kV requires **three** power lines each with **three** suspended conductors.
- When DC is used, the power flow in the line can be controlled. This stabilizes the transmission network and prevents cascading outages such as those we have experienced in Europe and the U.S. in recent years.
- HVDC requires converter stations at each end of the power line. This means that short power lines using DC are relatively expensive.

Since the Gotland HVDC link was commissioned in 1954, ASEA/ABB has been the leading company in the field. Voltage and power levels have risen, as shown by Figure 2 below:



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