HVDC TRANSMISSION FACTSHEET

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Technology

- A high-voltage direct current (HVDC) transmission link consists primarily of a **converter station,** in which the AC voltage of the conventional power grid is converted into DC voltage, a **transmission line**, and another **converter station** on the other end, where the arriving DC voltage is converted back into AC voltage.
- The electricity can be transported in **both directions**. The lines can go **across land** as overhead or underground lines, or be installed **in water** as submarine cables.
- Transmission losses are lower than for AC voltage. DC voltage amounts to several hundred thousand volts. The higher the voltage, the lower the transmission losses are, and the more electricity can be transmitted via the line.
- Siemens commissioned the **first HVDC transmission link rated at 800,000 volts** in China at the end of 2009, thereby establishing itself as a technology leader.
- Generally, an HVDC transmission link has **two poles** (and also two lines between them) over which half of the electricity is transmitted. If one pole or line were to fail, half of the remaining power would still be available.
- Besides conventional HVDC transmission technology, there is also the space-saving variant HVDC Plus, which is used especially on offshore platforms. In addition, HVDC Plus is the HVDC solution for built-up urban environments as can be encountered in San Francisco, for example.

Advantages:

- HVDC transmission has **30-50% less transmission loss** than comparable alternating current overhead lines. (For comparison: given 2500 MW transmitted power on 800 km of overhead line, the loss with a conventional 400-kv AC line is 9.4%; with HVDC transmission at 500 kV, it is only 6%, and at 800 kV HVDC it is just 2.6%.)
- Generally, given the same width of the cable run, **30-40% more energy transmission** is possible than with conventional overhead lines carrying alternating current.
- As a “safety fuse,” HVDC transmission can **prevent** the transmission of **faults** between connected AC grids.
- For lengths of **600 km or more, overhead lines using HVDC transmission technology are more cost-effective** than AC technology.
- **Cable links longer than 80 km are only possible with HVDC transmission.** That’s because for underground or submarine cables, hardly any electricity is delivered when AC lines are 80 km or longer (the cable’s insulation serves as a capacitor and becomes charged, thereby absorbing the electricity). For an HVDC transmission link using submarine cable, such as the one to Mallorca (at 250 kV and 400 MW), there will be an energy loss of only 0.9% per 100 km of cable as well as a conversion loss of about 1.5% (regardless of the link’s length) for both converter stations combined.

Market:

- The power transmission **market** is basically **volatile**, since it is influenced by **large-scale projects.**
- **The global power transmission market (incl. HVDC transmission) will amount to €6-8 billion per year in the next five years.**
- **The HVDC transmission market, which is included in this figure, is expected to at least double within the next five years from a current €3 billion per year.**
- **HVDC transmission** is the sector that is growing the fastest in the power transmission industry. In the meantime, it accounts for about **20 percent of the orders** at Siemens in the power transmission business.
- The demand for HVDC transmission is increasing rapidly. In the last 40 years, HVDC transmission links with a total capacity of **100 gigawatts** (equivalent to the capacity of 100 large power plants) were installed. Another **250 gigawatts** will be added in this decade alone!

- With a market share of about 40%, **Siemens** is one of the two biggest suppliers in the HVDC transmission sector.
- Siemens has completed about **40 HVDC transmission projects** worldwide, one quarter of which were in China. Through these Siemens-built HVDC transmission links flows an amount of electricity sufficient to meet the average power demand of entire countries, such as Spain or Italy.

Drivers:

- **Connecting offshore wind farms to the grid:** cable lengths of 80 km and more are only possible with HVDC transmission technology.
    - **Germany: Wind farm projects** are far offshore – due to landscape protection and higher wind yield (160 km of sea cable for Sylwin/Dan Tysk for example) – which practically creates a "northern Desertec" in the Baltic Sea
    - **Great Britain: Future wind farms** are far offshore due to the higher yield and because the **near-coastal regions** were **already contracted out** in rounds 1 and 2. For round 3 with 32 GW of wind power, areas have been identified for wind farms that are between 40 and 200 km off the coast.
- **Trans-national grid connections:** This creates integrated grids that can compensate for regional fluctuations in the production or consumption of electricity. For example: Inelfe (FR-ES) and BritNed (UK-NL)
- **Power supply for areas** in which **no new power plant** is to be built (often via lines running through water). Examples: Mallorca and San Francisco
- **Back-to-back links**, which connect two AC grids and serve as a "firewall" to prevent faults from passing into the neighboring grid (e.g., Georgia - Turkey, New York - New Jersey)
- **China, India, and Brazil in particular are boom countries,** because their energy demand is growing rapidly and large distances must be bridged to ensure a supply of electricity from renewables projects.

Quotes:

Udo Niehage, CEO of the Power Transmission Division in Siemens' Energy Sector:

"By 2020, I'm expecting to see new HVDC transmission lines with a total capacity of 250 gigawatts. That is a dramatic increase. In the last 40 years, we've only installed 100 gigawatts worth of HVDC transmission lines."

"Siemens is very interested in HVDC transmission technology. Additional HVDC transmission projects were awarded in Germany and Europe for the next 12 months."

"HVDC transmission is also suited for supplying power where a new power plant is not desired, would not be profitable, or lacks sufficient space. For example, in Mallorca, much more power is needed in the summer than in the winter. A new power plant would lie idle after the main season. With our HVDC transmission link, the island gets electricity from the mainland – of which16 percent is wind power and an almost identical amount is clean hydroelectricity."

"The Inelfe project which creates a link between France and Spain is an outstanding, trendsetting model for how bottlenecks in the Europe-wide transmission grids can gradually be overcome."

"Without new electricity highways extending from north to south, Germany's objectives to expand renewables could not be achieved."

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