

HIGH-VOLTAGE DIRECT CURRENT – HVDC

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High-Voltage Direct Current (HVDC) is a technology that uses direct current to transmit electric power over high-voltage lines. HVDC systems typically operate at voltages above 100 kV. This technology makes it possible to significantly reduce energy dissipations in the transmission process. Electric energy transmission utilizes special equipment including inverters and current converters to control the stream of power with a fine precision.

One of the main advantages of HVDC is the reduction of losses over long distances. In alternating current (AC) systems the losses are associated with volt-amperes reactive and inductance. The other advantages of HVDC include the following:

- smaller insulation distances than for alternating current at the same effective voltage value;
- the ability to control the direction and magnitude of the transmitted power;
- the possibility of converting existing AC lines into DC;
- absence of necessity of reactive power compensation stations.

HVDC allows large amounts of power to be transferred without significantly increasing the size and weight of the conductors. This can be achieved through higher DC electric energy throughput which reduces the size and weight requirements of cables and supports. For example, HVDC systems can transmit several thousand megawatts, which is impossible for traditional AC systems without a massive increase in infrastructure.

This makes HVDC ideal for interconnections between remote renewable source of power and large consumers.

HVDC systems offer greater flexibility in controlling power flows. They allow the regulation of flows between different regions which helps to improve load balancing and maintain the stability of the power

system. HVDC solves the problem of transferring dump energy from regions with high production to regions with high consumption and allows two completely independent energy facilities to be maintained.

HVDC systems provide a high degree of reliability and resilience to outages, which is critical in modern power systems. Unlike an AC system if a short circuit or other abnormality occurs HVDC quickly cuts off the current and minimizes equipment damage. This resilience improves the overall reliability of power circuit and reduces the number of emergency outages.

HVDC systems have a lower negative environmental impact than traditional AC lines. Smaller lines and cables mean that less land is required to install them helping to save ecosystems. In addition, HVDC systems can be less visually prominent and require fewer onerous structures and supports thereby minimizing the impact on the landscape.

There are constant innovations in HVDC technology including modern inverters and transformers that reduce costs and improve efficiency. New semiconducting materials such as carbon nano-tubes and silicon carbide increase electric control limits and reduce maintenance costs.

The future of high-voltage direct current transmission looks promising and is significantly linked to global trends in the energy sector. With the help of advances in technology HVDC is becoming an integral part of today's electrical infrastructure. Its ability to effectively integrate remote renewable source of power allows to optimize resource allocation and increase grid resilience.

Concurrently, the development of HVDC-based interstate and intercontinental grids will open up new opportunities for power exchange, reducing costs and carbon footprint. Although the technology faces some challenges, such as high capital costs and the need for standardization, its advantages make HVDC a relevant choice for the future of energy.

References

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