

## Electrical power transmission systems

Power transmission is the process of transporting electricity from power generation plants to substations, where it is distributed to end-users. This critical phase of the electrical grid enables electricity to be delivered over vast distances, ensuring that power is available for homes, businesses, and industries. Without efficient power transmission, large-scale distribution of electricity would be impossible, limiting access to this essential resource.

Transmission systems operate at high voltages to minimize energy loss, as electricity travels from generation points to regional substations. The system's efficiency and reliability depend on advanced technologies and infrastructure to maintain a stable power supply while reducing environmental impact. Understanding power transmission highlights its importance in modern infrastructure and its role in providing continuous, reliable access to electricity.

Advances in high-voltage direct current (HVDC) technology are enhancing DC transmission's efficiency and making it a viable alternative for specific, long-distance applications.

Efficiency in power transmission is critical to minimizing energy loss and reducing environmental impact. Transmission lines and equipment are designed to operate at high voltages to decrease resistance and energy dissipation. Key factors influencing transmission efficiency include:

Improving transmission efficiency is essential for reducing operational costs and environmental impact, making it a central focus in the development of modern transmission infrastructure.

Efforts to mitigate these impacts include underground transmission, advanced materials, and improved planning practices to reduce the ecological footprint of transmission infrastructure.

The power transmission sector is rapidly evolving, driven by advancements in technology, demand for sustainable energy, and infrastructure modernization. Key trends include:

These advancements will shape the future of power transmission, focusing on greater efficiency, reduced environmental impact, and improved access to clean energy.

Power transmission is a vital link in the energy supply chain, connecting power generation with consumption. As demand for reliable electricity grows and environmental challenges mount, innovations in transmission technology are essential to ensure efficient, resilient, and sustainable energy delivery. The future of power transmission promises a more integrated, cleaner, and adaptive grid that meets the energy needs of modern society.

The distribution grid is so large in comparison to most loads that it appears to be infinite, not only visually, but in most calculations as well. If a load took 100 A on each phase in a 400/230 V three-phase system, most apprentices would consider this a large load; however, a relatively small 500 MW power station can supply over 100,000 A per phase at 230 V. The entire grid has a much greater capacity than that.

What this means to the apprentice performing calculations for loads on the grid is that the voltage, frequency and phase difference between lines are fixed, and not able to be changed by any relatively small load that we apply.

Electrical power can be transmitted using low voltage and high current, but higher current results in higher transmission losses according to the formula  $E = I^2RT$ . Therefore, to reduce what are known as  $I^2R$  losses, transmission lines generally use high voltage and low current.

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