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Electric power transmission

- Electric power transmission a process in the delivery of electricity to consumers is the bulk transfer of electrical power. Typically, power transmission uses an electricity network connecting the power plant to multiple substations near a populated area.

Electricity distribution is the delivery from the substation to the consumers. Electric power transmission allows distant energy sources (such as hydroelectric power plants) to be connected to consumers in population centers. Due to the large amount of power involved and to reduce losses, transmission normally takes place at high voltages (110 kV or above). Electricity is usually transmitted over long distance through overhead power transmission lines.

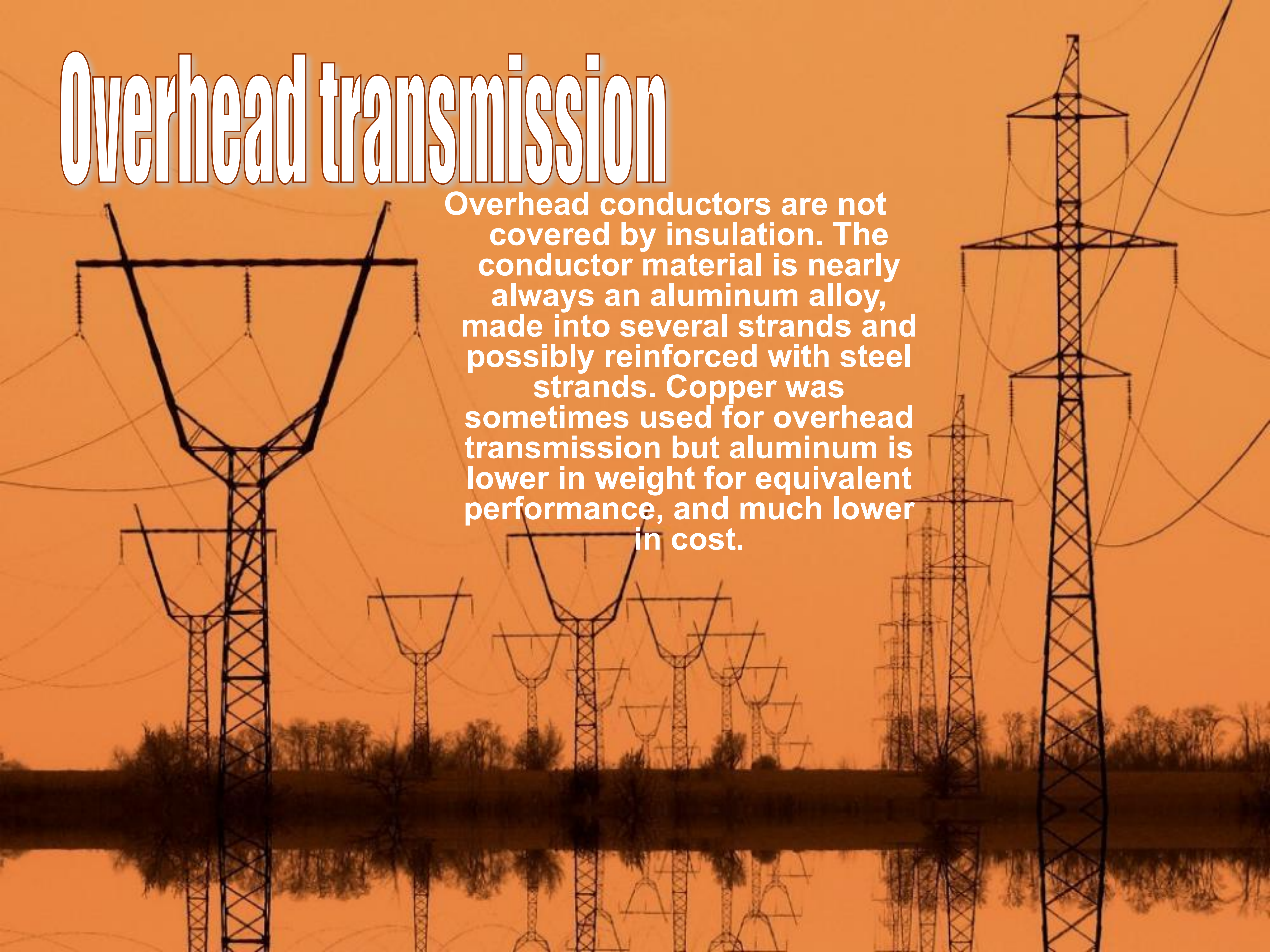
- Underground power transmission is used only in densely populated areas because of its high cost of installation, maintenance and difficulties in voltage management. Power can be routed from any power plant to any load center, through a variety of routes. Much analysis is done by transmission companies to determine the maximum reliable capacity of each line.

AC power transmission

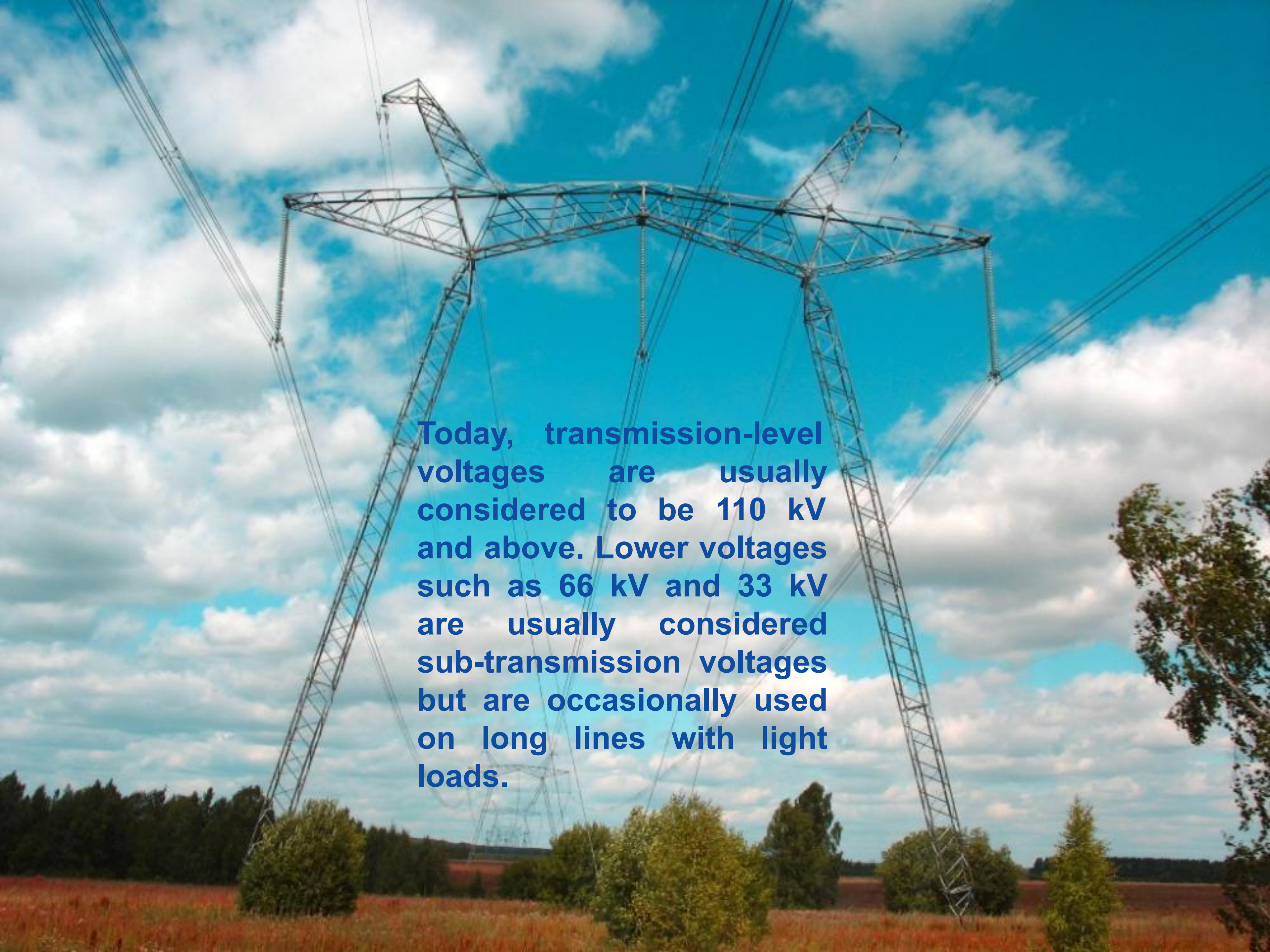
- AC power transmission is the transmission of electric power by alternating current. Usually transmission lines use three phase AC current. Single phase AC current is sometimes used in a railway electrification system.

Overhead transmission

Overhead conductors are not covered by insulation. The conductor material is nearly always an aluminum alloy, made into several strands and possibly reinforced with steel strands. Copper was sometimes used for overhead transmission but aluminum is lower in weight for equivalent performance, and much lower in cost.



- Overhead conductors are a commodity supplied by several companies worldwide. Improved conductor material and shapes are regularly used to allow increased capacity and modernize transmission circuits.



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.

Overhead transmission lines are uninsulated wire, so design of these lines requires minimum clearances to be observed to maintain safety. During 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.

During adverse weather conditions of high wind and low temperatures, overhead conductors can exhibit wind-induced oscillations which can encroach on their designed clearances. Depending on the frequency and amplitude of oscillation, the motion can be termed gallop or flutter.

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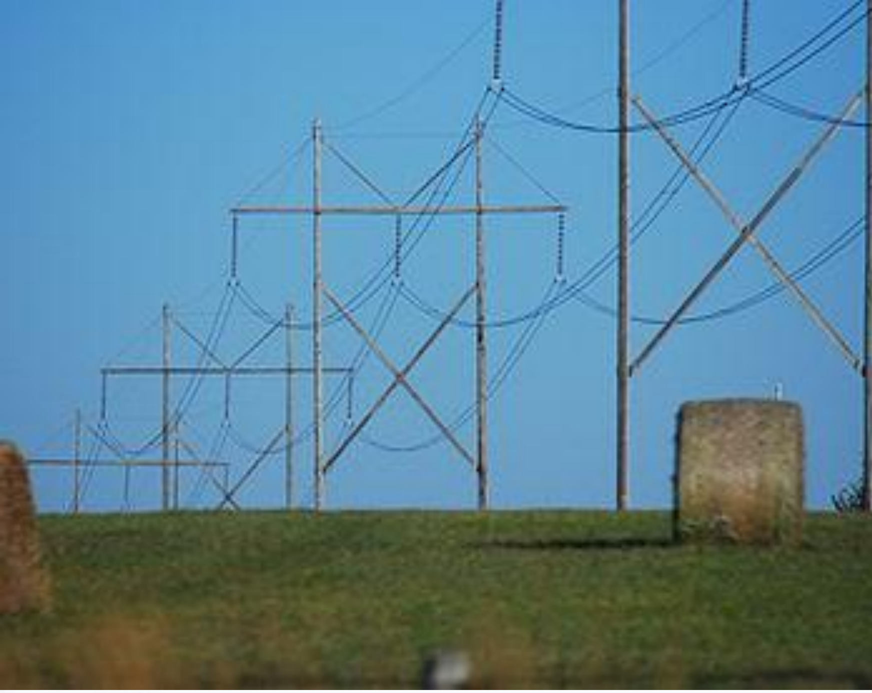
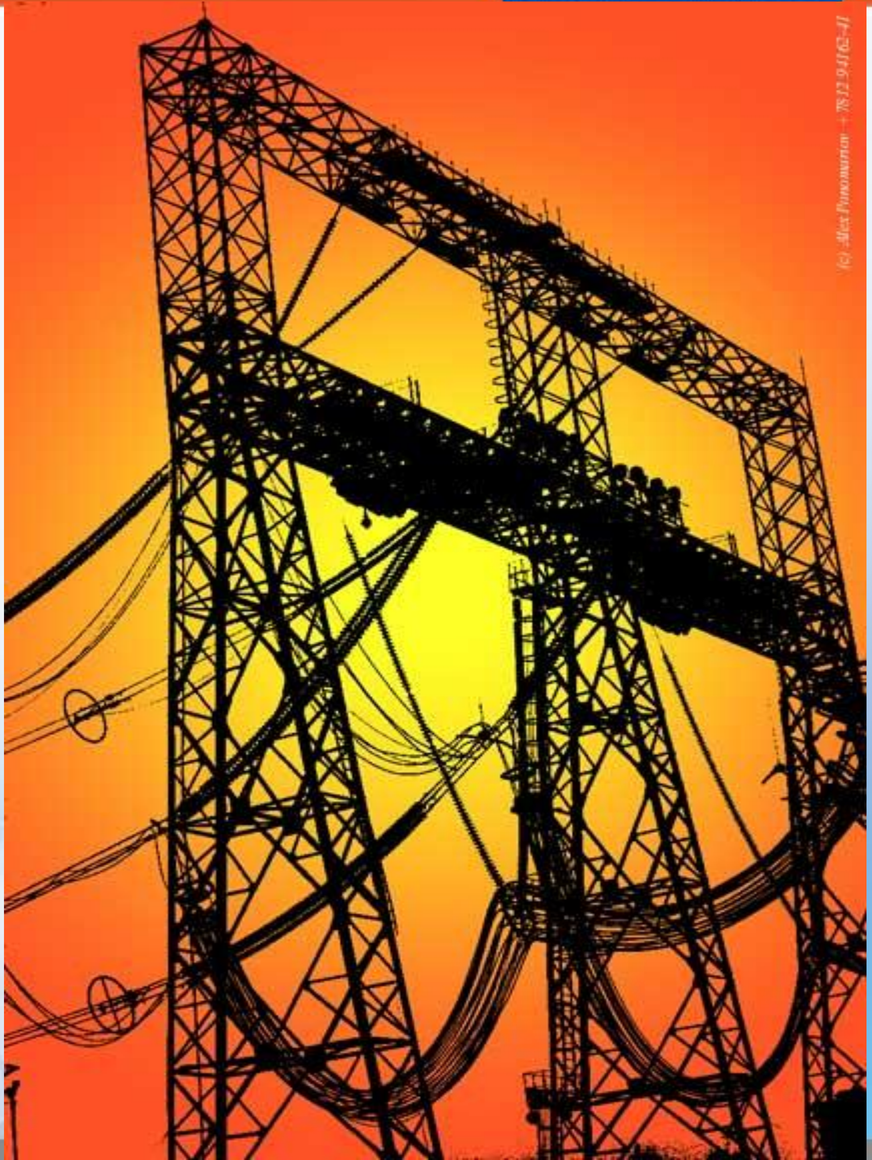


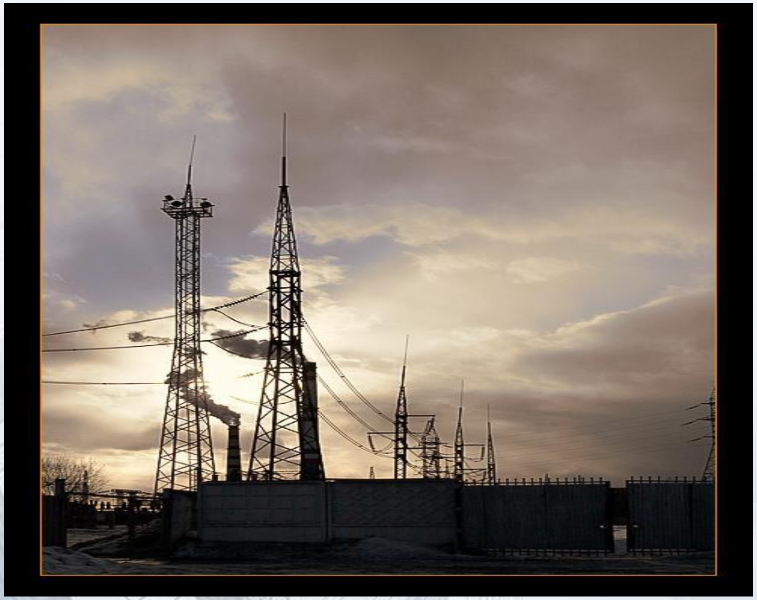
Transmission lines in Kansas.

Underground transmission

- Electric power can also be transmitted by underground power cables instead of overhead power lines. This is a more expensive option, as the life-cycle cost of an underground power cable is two to four times the cost of an overhead power line.



However, they can assist the transmission of power across:



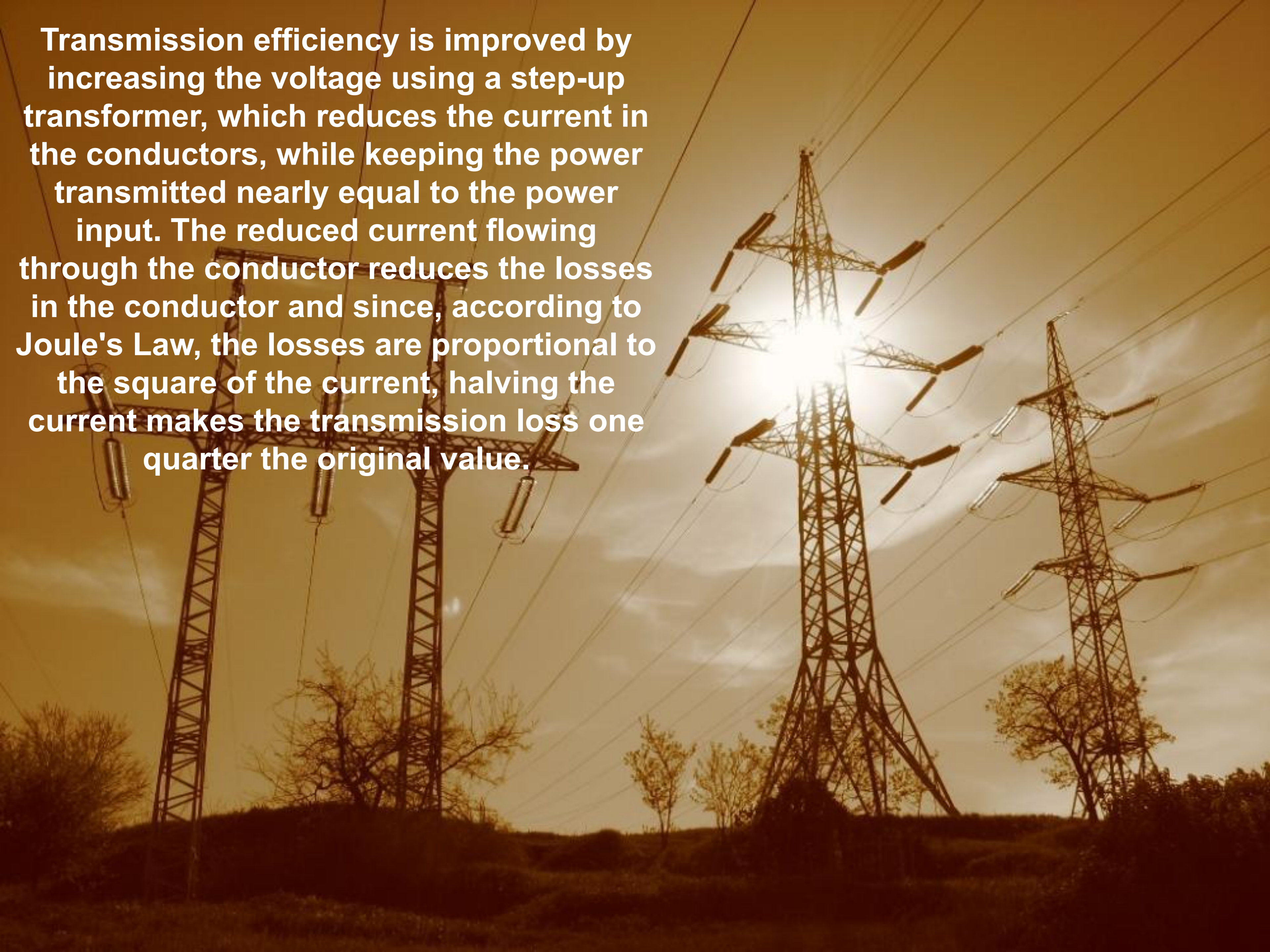
- Densely populated urban areas
- Areas where land is unavailable or planning consent is difficult
- Rivers and other natural obstacles
- Land with environmental heritage
- Areas of significant or prestigious infrastructural development
- Land whose value must be maintained for future urban expansion and rural development.

- Compared to overhead lines, underground cables emit much less powerful magnetic fields. (All conductors carrying current which varies with respect to time generate magnetic fields.) Underground cables need a narrower strip of about 1- 10metres to install, whereas the lack of cable insulation requires an overhead line to be installed on a strip of about 20-200metres wide to be kept permanently clear for safety, maintenance and repair. Those advantages can in some cases justify the higher investment cost.

Bulk power transmission

Engineers design transmission networks to transport the energy as efficiently as feasible, while at the same time taking into account economic factors, network safety and redundancy. These networks use components such as power lines, cables, circuit breakers, switches and transformers.

A transmission substation decreases the voltage of electricity coming in allowing it to connect from long distance, high voltage transmission, to local, lower voltage, distribution. It also reroutes power to other transmission lines that serve local markets.



Transmission efficiency is improved by increasing the voltage using a step-up transformer, which reduces the current in the conductors, while keeping the power transmitted nearly equal to the power input. The reduced current flowing through the conductor reduces the losses in the conductor and since, according to Joule's Law, the losses are proportional to the square of the current, halving the current makes the transmission loss one quarter the original value.

- A transmission grid is a network of power stations, transmission circuits, and substations. Energy is usually transmitted within the grid with three-phase AC. DC systems require relatively costly conversion equipment which may be economically justified for particular projects. Single phase AC is used only for distribution to end users since it is not usable for large polyphase induction motors.

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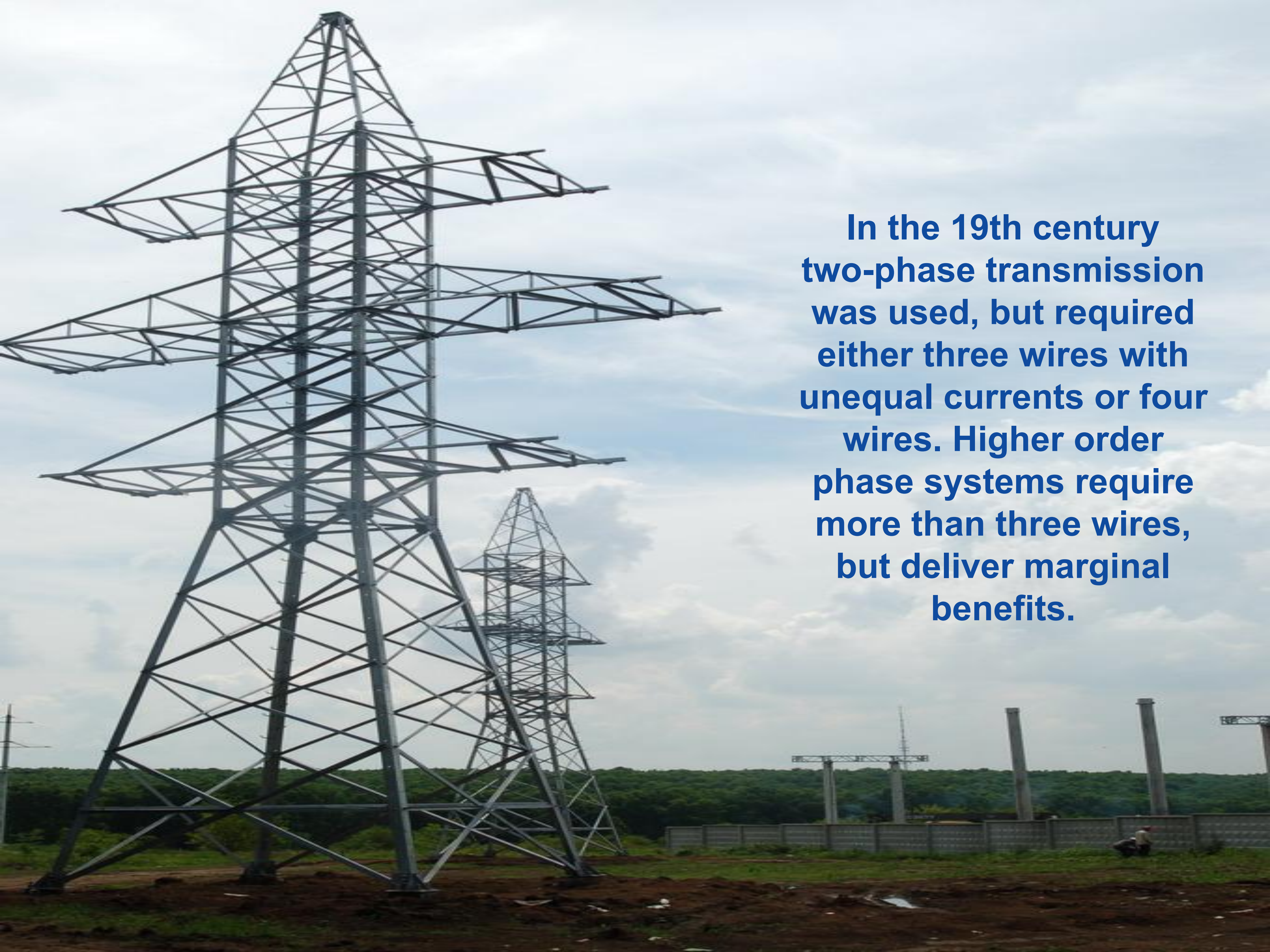
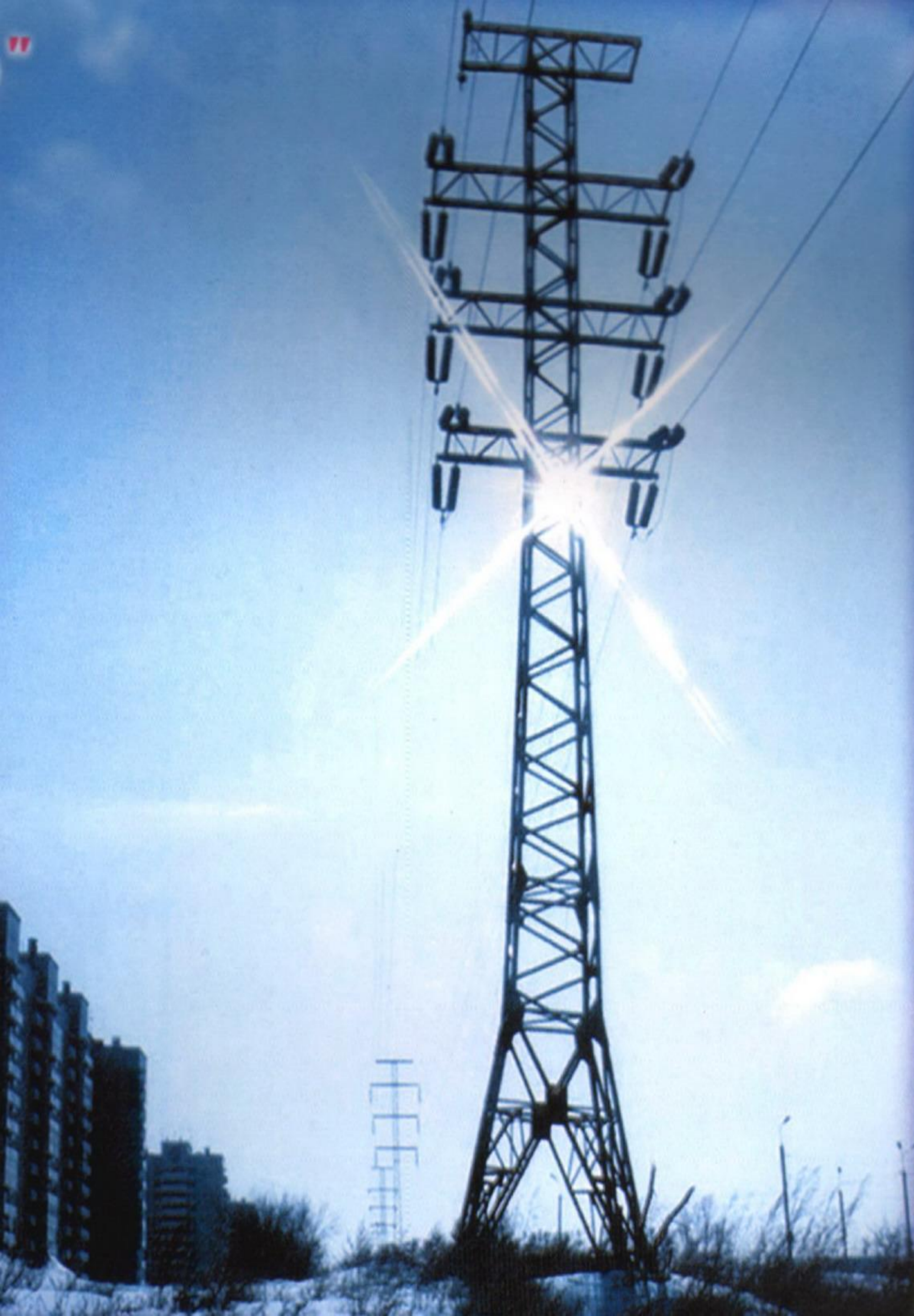
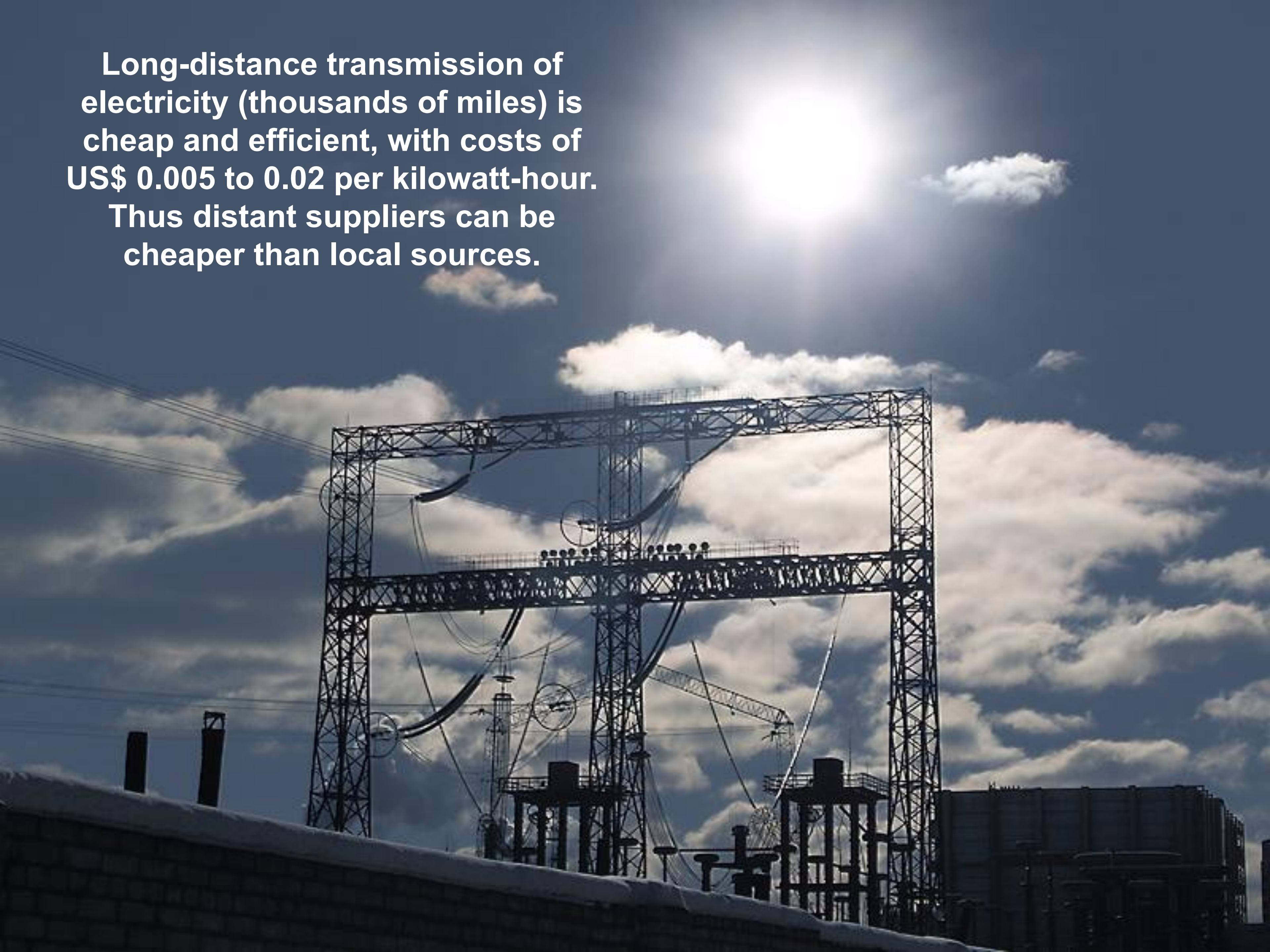


In the 19th century two-phase transmission was used, but required either three wires with unequal currents or four wires. Higher order phase systems require more than three wires, but deliver marginal benefits.



- 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 of the 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 a few links are inoperative.


Long-distance transmission of electricity (thousands of miles) is cheap and efficient, with costs of US$ 0.005 to 0.02 per kilowatt-hour. Thus distant suppliers can be cheaper than local sources.

- **Multiple local sources (even if more expensive and infrequently used) can make the transmission grid more fault tolerant to weather and other disasters that can disconnect distant suppliers.**

END