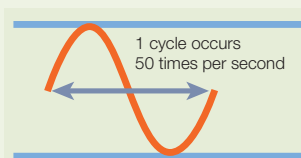


factsheet

High Voltage Direct Current
electricity – the facts**What is AC electricity?**

The electricity that supplies most of the world's homes and businesses is alternating current (AC). Power stations produce AC electricity at high voltages but, using transformers at substations, the voltage of the electricity is increased further to transmit it through National Grid's network, which operates at 400,000 and 275,000 volts. Overhead lines and underground cables transmit the electricity to towns and cities, where another set of transformers reduces the voltage so that the electricity can be distributed to homes and businesses.

In the UK the whole electricity grid system operates at the same system frequency. Frequency is the speed with which the current alternates and in the UK this happens 50 times every second or 50 Hertz (Hz). This diagram



shows how an alternating current creates a waveform as it moves between the maximum and minimum positions.

All the electricity produced at power stations that goes on to supply our televisions, fridges and mains lighting is AC and has a frequency of 50Hz.

The combination of AC electricity and transformers allows electricity to be transported across the electricity system and minimises the amount of electricity lost due to the resistance within electricity conductors. Power systems worldwide have been developed on this technology.

What is DC electricity?

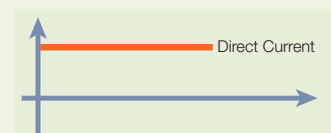
Direct current (DC) electricity, in contrast to AC, flows in one direction in a wire or cable and the voltage cannot be increased or decreased using



“The combination of AC electricity and transformers allows electricity to be transported across the electricity system and minimises the amount of electricity lost due to the resistance within electricity conductors.”

transformers as it can with AC electricity. For example, a torch battery uses DC electricity – attaching a wire at either end of the battery allows electricity to flow in one direction through the wire powering the light. As shown below, DC flows in one direction.

DC electricity did not develop as the means of transmitting bulk power supplies from



power stations because it required special electrical equipment to allow conversion to higher voltages, which was expensive and unreliable in the early days of electricity transmission. This meant that the electrification of whole countries was delivered quickly and efficiently by adopting AC technology rather than DC. This largely remains the case today, with AC providing the most efficient solution, especially over short distances.

“HVDC technology is therefore used primarily for connections to other countries or between remote parts of the network.”



However, High Voltage Direct Current (HVDC) transmission is used in some special cases where it has technical or economic advantages over AC transmission. For example, HVDC is used to connect independent power systems with each other, such as those in Europe with the UK, or to connect very remote power stations, such as offshore wind farms, to the main transmission network.

Connecting independent electricity systems with HVDC electricity

A small amount of electricity currently arrives at National Grid's network through HVDC cables from other countries' power systems. There are HVDC links with France and with Northern Ireland. Others are under construction to Holland and to the Republic of Ireland, while a link to Norway is also being considered.

HVDC provides a practical solution to moving electricity from one country to another, because it protects each country's AC electricity system from any frequency changes in the other.

The process works by converting AC to DC at a converter station. The DC electricity is then transmitted to the other end and on arrival converted, at another converter station, to the AC voltage and frequency of the receiving country or network. When converting electricity at very high voltages, the converter stations often need to be very large – for example, the size of a football pitch.

Transmitting HVDC electricity over long distances

When transmitting electricity over extremely long distances, HVDC is more efficient than AC. This is because the amount of electricity “lost” during AC transmission is greater than that lost in HVDC

systems over long distances. HVDC becomes more efficient than AC when the distances to be covered are in the hundreds of kilometres. For example, in China, the Changzhou HVDC project provides a link to Shanghai some 850km away via HVDC overhead lines.

Why can't HVDC be used everywhere?

The UK electricity system is an integrated network of transmission lines and substations, all designed to provide safe and reliable electricity supplies. The distances between substations are relatively short, in the tens of kilometres, and using HVDC in these circumstances would be very expensive and much less efficient.

HVDC technology is therefore used primarily for connections to other countries or between remote parts of the network.

How much does HVDC cost?

The cost of HVDC increases with the amount of electrical power it is required to transfer and the distance of transmission. This is because of the increased cost of converter stations and the extra cables required when more power is being transferred.

An AC overhead line can transport large quantities of power. For the highest voltage levels used in the UK, transfer capacities of 6000MW and above can be achieved at costs in the hundreds of millions of pounds (depending on the length of the line). However, an HVDC cable can transmit only 2000MW. For an HVDC solution to provide similar capacity of 6000MW, several cables would be required and the costs would be measured in billions of pounds.

For further information regarding DC technology please refer to our more detailed HVDC factsheet.