Section A

Pre-reading

1 Match the items in Column A with their translations in Chinese in Column B.

Column A	Column B
___ 1. power system	A. 交流电源
___ 2. the grid	B. 输电系统
___ 3. generators	C. 电力系统
___ 4. transmission system	D. 汽轮发电机
___ 5. alternating current power	E. 转子
___ 6. direct current power	F. 输电网
___ 7. turbo generator	G. 直流电源
___ 8. rotor	H. 发电机

2 Discuss the following questions with your partner.

1. What are the components of an electric power system? What role does each component play in the electric power system?
2. Can you list some energy sources that can produce electric power? What are the advantages and disadvantages of these sources?

Electric Power Systems

Text A

1 An electric power system is a network of electrical components deployed to supply, transfer, and use electric power. An example of an electric power system is the network that supplies a region's homes and industry with power – for sizeable regions, this power system is known as the grid and can be broadly divided into the generators that supply the power, the transmission system that carries the power from the generating centres to the load centres and the distribution system that feeds the power to nearby homes and industries. Smaller power systems are also found in industry, hospitals, commercial buildings and homes. The majority of these systems rely upon three-phase AC power – the standard for large-scale power transmission and distribution across the modern world. Specialised power systems that do not always rely upon three-phase AC power are found in aircraft, electric rail systems, ocean liners and automobiles.

2 All power systems have one or more sources of power. For some power systems, the source of power is external to the system but for others it is part of the system itself. DC power can be supplied by batteries, fuel cells or photovoltaic cells. AC power is typically supplied by a rotor that spins in a magnetic field in a device known as a turbo generator. There have been a wide range of techniques used to spin a turbine's rotor, from steam heated rotor using fossil fuel (including coal, gas and oil) to nuclear energy, falling water (hydroelectric power) and wind (wind power).

3 Power systems deliver energy to loads that perform a function. These loads range from household appliances to industrial machinery. Most loads expect a certain voltage and, for AC devices, a certain frequency and number of phases. The appliances found in your home, for example, will typically be single-phase operating at 50 or 60 Hz with a voltage between 110 and 260 volts (depending on national standards). An exception exists for centralized air conditioning systems, as these are now typically three-phase because this allows them to operate more efficiently. All devices in your house will also have a wattage, which specifies the amount of power the device consumes. At any one time, the net amount of power consumed by the loads on a power system must equal the net amount of power produced by the supplies less the power lost in transmission.

4 Conductors carry power from the generators to the load. In a grid, conductors may be classified as belonging to the transmission system, which carries large amounts of power at high voltages (typically more than 69 kV) from the generating centres to the load centres, or the distribution system, which feeds smaller amounts of power at lower voltages (typically less than 69 kV) from the load centres to nearby homes and industry.

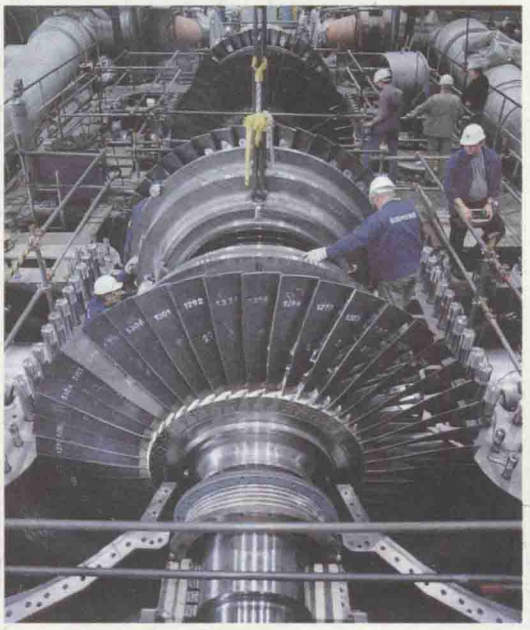
5 Choice of conductors is based upon considerations such as cost, transmission losses and other desirable characteristics of the metal, like tensile strength. Copper, with lower resistivity than Aluminum, was the conductor of choice for most power systems. However, Aluminum has lower cost for the same current carrying capacity and is the primary metal used for transmission line conductors. Overhead line conductors may be reinforced with steel or aluminum alloys.

6 Electricity grid systems connect multiple generators and loads operating at the same frequency and number of phases, the commonest being three-phase at 50 or 60 Hz. However, there are other considerations. These considerations range from the obvious: How much power should the generator be able to supply; What is an acceptable length of time for starting the generator (some generators can take hours to start); Is the availability of the power source acceptable (some renewables are only available when the sun is shining or the wind is blowing); to the more technical: How should the generator start; What is the mechanical speed of operation for the turbine and consequently what is the number of poles required; What type of generator is suitable (synchronous or asynchronous) and what type of rotor (squirrel-cage rotor, wound rotor, salient pole rotor or cylindrical rotor) is appropriate?

7 Electric power is the product of two quantities: current and voltage. These two quantities can vary with respect to time (AC power) or can be kept at constant levels (DC power). Solid state devices, which are products of the semiconductor revolution, make it possible to transform DC power to different voltages, build brushless DC machines and convert between AC and DC power. Nevertheless, devices utilizing solid state technology are often more expensive than their traditional counterparts, so AC power remains in widespread use.

8 Most refrigerators, air conditioners, pumps and industrial machinery use AC power whereas most computers and digital equipment use DC power (the digital devices you plug into the mains typically have an internal or external power adapter to convert from AC to DC power). AC power has the advantage of being easy to transform between voltages and is able to be generated and utilized by brushless machinery. DC power remains the only practical choice in digital systems and can be more economical to transmit over long distances at very high voltages.

9 The ability to easily transform the voltage of AC power is important for two reasons. Firstly, power can be transmitted over long distances with less loss at higher voltages. So in power systems where generation is distant from the load, it is desirable to step-up (increase) the voltage of power at the generation point and then step-down (decrease) the voltage near the load. Secondly, it is often more economical to install turbines that produce higher voltages than would be used by most appliances, so the ability to easily transform voltages means this mismatch between voltages can be easily managed.



A steam turbine used to provide electric power

10 Making sure that the voltage, frequency and amount of power supplied to the loads are in line with expectations is one of the great challenges of power system engineering. However, it is not the only challenge. In addition to the power used by a load to do useful work (termed real power), many AC devices also use an additional amount of power because they cause the alternating voltage and alternating current to become slightly out-of-sync (termed reactive power). The reactive power like the real power must balance (the reactive power produced on a system must equal the reactive power consumed) and can be supplied from the generators, however it is often more economical to supply such power from capacitors.

New words and expressions

deploy /dɪ'plɔɪ/ *vt.*
to distribute systematically or strategically 配置；部署

photovoltaic /ˌfəʊtəʊvɒl'teɪɪk/ *adj.*
producing a voltage when exposed to radiant energy (especially light) 光电的

hydroelectric /ˌhaɪdrəʊɪ'lektrɪk/ *adj.*
of or relating to or used in the production of electricity by waterpower 水力发电的

wattage /'wɒtɪdʒ/ *n.*
the product of voltage and current 瓦特数

less /les/ *prep.*
subtracting 减去

ocean liner 远洋定期客轮

fossil fuel 矿物燃料；化石燃料

overhead line conductor 架空导线

aluminum alloy 铝合金

solid state device 固态器件

power adapter 电源适配器

brushless machinery 无刷机械

real power 实际功率；有效功率

reactive power 无功功率