ALTERNATE FORMS OF ENERGY IN RELATION TO THE GENERATION OF ELECTRICITY

The need for energy today is greater than it has ever been. In order to satiate this burgeoning requirement for energy (electricity), newer, safer, cleaner and, most important of all, renewable sources of energy have been lined up to replace the conventional methods. Of course, it was only a matter of time before new methods would have to be researched and enforced due to the sheer weight of problems caused by nuclear and fossil fuels: pollution of many types (visual, audio and atmospheric) and unmanageable costs.

Generally, methods of electricity generation vary according to economic resources, but patterns of generation are similar internationally. Modern electric generators typically give an a.c. output of around 20,000 V at a frequency of either 50 or 60 Hz. A three-phase a.c. transmission system is usually used, in which three conductors carry alternating currents that are out of step by one-third of a cycle: this gives a constant flow of power, and hence much smoother and more efficient operation than with a single-phase system. For long-distance transmission, the generated voltage is stepped up using transformers to around 270,000 V, or up to 500,000 V on certain long -distance sections. Very high voltages are used because this substantially cuts power losses in the cables. The voltage is then stepped down for domestic supply at local substations, to values of between 110 and 240 V, depending on the supply standards of the country. All common electricity grids are a.c. systems, but recent developments in technology and the development of superconducting cables have led to renewed interest in d.c. distribution systems. Direct-current transmission is competitive over long distances because a cable can carry between two and ten times as much d.c. power as a.c. Long-distance power transmission in most countries is via overhead pylons, while urban distribution is usually by underground cable.

There are **seven** different types of renewable fuel: wave, tidal, geothermal, solar, wind, bio-mass and hydro-electric. Below is a description of each type and their role in power generation.

Wave Power is the use of the energy of wave motion in the sea to generate electricity. Wave-power generators of various types have been developed, the best known being the "nodding-duck" type, which consists of a string of floats that bob up and down in the waves. The bobbing motion turns a generator. It is estimated that there are between 50 and 100 kilowatts of power per metre in the waves off the coast of Britain, a total of 120 gigawatts over all the suitable sites. However only a fraction of this would become electricity. One of the disadvantages of wave power is that it is variable and unpredictable although, like wind power, its peak output is likely to coincide with peak demand. Another is that since it is sited off the coast it may be obstructive to shipping and difficult to maintain. In addition, the design and construction of generators and transmission lines to work at sea presents a formidable engineering problem.

Tidal Power is used to generate electricity by using the tides to collect water behind a barrage and releasing it to turn a turbo generator. The Severn estuary, with its tidal rise of 8.8 m, could generate 7% of the UK's electricity demand; however, the capital cost, estimated as £ 8 billion, is regarded as prohibitive, although French experience with their tidal power station on the River Rance indicates a payback period of only 16 years. It is estimated that 34 UK sites could generate 100 MW each, but the Severn barrage is the one currently most likely to be built. Russia also has a tidal power station on the White Sea and others are planned.

Geothermal power is heat produced in the earth's interior, which can provide a source of alternative energy. Volcanoes, geysers, and hot springs are all sources of geothermal power, although only the latter two provide convenient energy sources. Countries that make use of geothermal power include Iceland, Italy, New Zealand, and the USA. Although geothermal power is being actively explored, it currently supplies only about 0.1% of the world's energy. In the UK, although theoretically it could supply a high proportion of electrical energy, in practice the very deep drilling required involves unsolved technical problems.

Solar power - the use of the sun's energy to provide heating or to generate electricity. A vast amount of solar energy (about 3 x 1024 joules) falls on the earth every year. This energy can be converted into heat, the commonest method being by heating water flowing through special **solar panels** on the roof of a building. The temperature rise produced is small but it reduces the energy required from other sources for hot water and space heating. As some 45% of energy is used in space heating buildings in the UK, solar heating could make a considerable contribution to UK energy needs. Higher temperatures, to raise steam for electricity generation, are possible using mirrors to focus the sun's rays in a **solar furnace**. It is estimated that 7000 square metres of mirror are required to generate 1 megawatt by boiling water to drive a turbogenerator. Direct conversion of solar radiation into electrical energy is possible with **solar cells**. These consist of semiconductor junctions in silicon crystals that are sensitive to the photovoltaic effect. The method is used mainly in small-scale applications, for example powering remote monitoring equipment, spacecraft, marine beacons, etc. For this method to have wider commercial applications the cost of solar cells would need to be reduced.

Wind power - the use of wind energy to generate electricity. Because of the world shortage of conventional energy resources, wind turbines (aerogenerators), like other alternative energy sources, have now become more attractive economically. Advantages of wind power are that it is free from pollution and uses no fuel. Disadvantages are that it must usually be supplemented by other schemes, including electricity storage, and the best sites are on open ground rather than in the cities, where most power is needed. Moreover, **wind farms** (groups of a few hundred wind turbines) occupy large areas of the countryside. For example, to produce 1 gigawatt of power (a modern nuclear power station produces about 1.2 GW) a farm would need to occupy nearly 400 sq km (150 sq mi).
There are several designs of aerogenerator: some with a horizontal axis and blades like the windmill; some with specially shaped blades rotating on a vertical axis. In either case the power output is given by 1/2C[pi]Av3, where C is a machine efficiency factor (usually 0.1-0.5), [rho] is the air density, A is the area swept by the blades, and v is the wind speed. A considerable number of wind farms are now supplying the grid in the UK, USA, and elsewhere. California, for example, has a capacity of 1200 MW from wind energy. In the UK in 1995 wind farms generated energy equal to over 30 million tonnes of oil equivalent. Small aerogenerators can be useful for isolated dwellings.

Biofuel - a source of energy based on biomass, the natural material of living organisms, including vegetable matter (from algae to trees), animal tissue, and manure. Biomass can be burned directly, or chemically or biologically processed into more convenient solid, liquid, or gaseous fuels. Forestry has provided wood as a biofuel over many centuries. Wood, other plant materials, and dried dung are still used in non-industrialized areas of the world for heating water and for cooking. Waste materials from agriculture and forestry can serve as biofuels for furnaces and boilers. Heating wood or other vegetable matter in the absence of air produces a gas with a high proportion of methane, together with an oily tar and a solid carbon or charcoal residue. All three products can be used as biofuels, although the tar requires further processing. Methane gas is also produced as a biofuel - biogas - by the bacterial fermentation of wastes with a high water content, such as human waste, animal manure, and crop residues. This process, which is used in China and India among other countries, also converts the wastes into nitrogen-rich fertilizer. Sewage works in the UK generate most of the heat and power they require by burning the methane gas produced from sewage fermentation.

Hydroelectric power - electricity generation using the energy of falling water. The water turns a turbine connected to an alternator, generating electricity with an efficiency of over 90% at full load and generally over 60% at quarter-load. Water is led through pipes from high-level natural or artificial reservoirs to the power station. Lower-level reservoirs and dammed rivers are also used in some situations. The higher the reservoir, the less water is needed for the same power output. Hydroelectric power is, therefore, a cheap power source in mountainous areas with high rainfall. Unfortunately these are not usually near the industrial communities that consume the most power. Also, because it depends on rainfall, hydroelectricity has to be backed by other power sources. In **pumped storage** stations, electricity is stored by using it to drive pumps that raise the water to a high-level reservoir. In times of high demand this water is run back through the turbines. Hydroelectricity is a renewable energy source causing no pollution; it currently provides 2.4% of world energy needs but only 0.2% of UK energy.