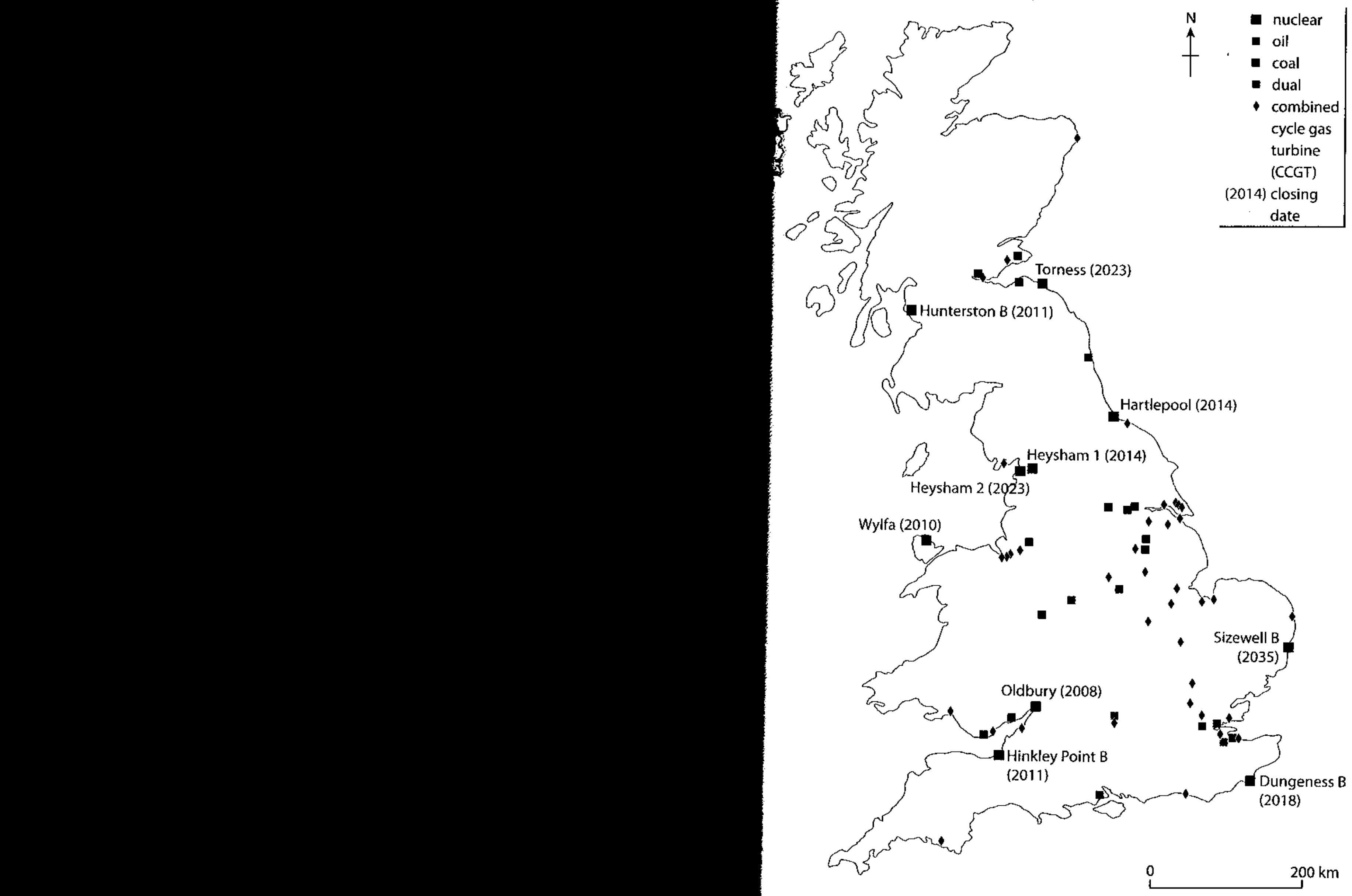

Figure 18.12

Power stations in the UK with 50 MW or more capacity, 2008

Iodine, with a half-life of 8 days, becomes 'safe' relatively quickly. In contrast, plutonium 239, produced by nuclear reactors, has a half-life of 250 000 years and may still be dangerous after 500 000 years. The two worst radioactive accidents resulted from the melt-down of reactor cores at Three Mile Island in the USA (1979) and at Chernobyl in Ukraine (1986). Fortunately there was no such leak when the world's largest nuclear power plant was forced to close following an earthquake in Japan in 2007. It was mainly for economic and safety reasons that British nuclear power stations (Figure 18.12) were built on coasts and estuaries where there is water for cooling and cheap, easily reclaimable land well away from major centres of population. However, the British government had to agree in 1998, following renewed calls from several EU countries, to make a large reduction in discharges into the Irish Sea from Sellafield.

Renewable energy

With the depletion of oil and gas reserves during the early years of the 21st century and the unfavourable publicity given to all types of fossil fuels, especially regarding their contribution towards global warming, renewable energy resources are likely to become increasingly more attractive. They are likely to become more cost-competitive, offer greater energy diversity, and allow for a cleaner environment. As shown in Figure 18.1, there are two types of renewable energy:

- **Continuous sources** are recurrent and will never run out. They include running water (for hydro-electricity), wind, the sun (solar), tides, waves and geothermal.
- **Flow sources** are sustainable providing that they are carefully managed and maintained (Framework 16, page 499). Biomass, including the use of fuelwood, is sustainable in that it has a maximum yield beyond which it will begin to become depleted.

Hydro-electricity

Hydro-electricity is the most widely used commercially produced renewable source of energy (fuelwood is used by more people and in more countries). Its availability depends on an assured supply of fast-flowing water which may be obtained from rainfall spread evenly throughout the year, or by building dams and storing water in large reservoirs. The initial investment costs and levels of technology needed to build new dams and power stations, to install turbines and to erect pylons and cables for the transport of the electricity to often-distant markets, are high. However, once a scheme is operative, the 'natural, continual, renewable' flow of water makes its electricity cheaper than that produced by fossil fuels.

Although the production of hydro-electricity is perceived as 'clean', it can still have very damaging effects upon the environment. The creation of reservoirs can mean large areas of vegetation being cleared (Tucurui in Amazonia), wildlife habitats (Kariba in Zimbabwe) and agricultural land (Volta in Ghana) being lost, and people being forced to move home (Aswan in Egypt and the Three Gorges Dam in China – Places 82, page 544). Where new reservoirs drown vegetation, the resultant lake is likely to become acidic and anaerobic. Dams can be a flood risk if they collapse or overflow (Case Study 2B), have been linked to increasing the risk of earthquake activity (Nurek Dam in Tajikistan) and can trap silt previously spread over farmland (Nile valley, Places 73, page 490). Despite these negative aspects, many countries rely on large, sometimes prestigious, schemes or, increasingly in less developed countries, on smaller projects using more appropriate levels of technology (Case Study 18).

Wind

Wind is the most successful of the new renewable technologies. Wind farms are best suited to places where winds are strong, steady and reliable and where the landscape is either high or, as on coasts, exposed. Although expensive to build – wind farms cost more than gas or coal-fired power stations – they are cheap and safe to operate. Most of Britain's new wind farms are to be located offshore where, although more costly to construct, winds are more reliable than on land. As wind farms are mainly pollution free, they do not contribute to global warming or acid rain and they should significantly contribute to world commitments to reduce carbon dioxide emissions by 60 per cent by 2050. Winds, especially in Western Europe and California, are strongest in winter when demand for electricity is highest. Wind farms can provide extra income for farmers who could earn more from them than they could from growing a crop on the same-sized plot. Wind farms also create extra jobs for people living in rural areas and in the electricity generation supply chain. As fossil fuels become less available, countries will have to become increasingly dependent on renewables such as wind.

However, British environmentalists are now less supportive of wind power than they originally were. This is partly because many of the actual and proposed wind farms are in areas of scenic attraction, where they are visually intrusive, or too close to important wildlife habitats. In an attempt to make them more efficient, turbines are becoming increasingly tall – over 50 m on onshore wind farms and even higher on those located offshore, where some could be taller than the Canary Wharf tower. Elsewhere, local residents complain of noise and impaired radio and TV reception, while others claim that the rotating blades are a danger to birds, the turbines can affect airport radar systems, and that electricity costs are higher than for power from fossil fuels and nuclear energy. As yet, electricity companies cannot store surplus power for times when wind power cannot be produced, i.e. during calms or when the wind is less than about 15 km/hr which could be during very cold winter anticyclonic conditions (page 234); or during gales when winds are over 55 km/hr and wind farms must shut down for safety reasons. Both eventualities are times when demand is likely to be greatest.

Although the first large-scale wind farms were located in California (Figure 18.13) and the USA still has over one-quarter of the world's capacity, the fastest growth is in the EU, notably in Spain and Germany, and the emerging countries of China and India.

Places 81 California and the UK: wind farms

California

Most wind farms in the USA have been developed by private companies. The developers, who use either their own or leased land, sell electricity to electric utilities. At present, 90 per cent of the USA's capacity comes from California. California's wind farms are in an ideal location mainly because peak winds occur about the same time of year as does peak demand for electricity in the large cities nearby. Approximately 16 000 turbines within the state produce enough electricity to supply a city the size of San Francisco. The three largest wind farms are at Altamont Pass (east of San Francisco), Tehachapi (between the San Joaquin Valley and the Mojave Desert) and San Gorgonio (north of Palm Springs). The Altamont Pass, with 7000 turbines, is one of the largest wind farms in the world (Figure 18.13). The average wind speed averages between 20 and 37 km/hr. The land is still used for cattle grazing as there is only one turbine for every 1.5–2 ha.

Figure 18.13

Wind farm at Altamont Pass, California

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'An Appropriate Technology is exactly what it says – a technology appropriate or suitable to the situation in which it is used [page 576]. If that situation is a highly industrialised urban centre the appropriate technology may well be "high tech". If, however, the situation is a remote Nepalese village "appropriateness" will be measured in the following terms:

- Is it culturally acceptable?
- Is it what people really want?
- Is it affordable?
- Is it cheaper or better than alternatives?
- Can it be made and repaired with local material, by local people?
- Does it create new jobs or protect existing ones?
- Is it environmentally sound?

For many decades "Aid" meant sending out the same large-scale, expensive, labour-saving technologies that we use: huge hydro-electric schemes, coal-fired power stations, diesel-powered generators. In some cases, for example towns and industrial areas, these have been appropriate. But such schemes do not reach the poorer communities in the rural areas. What was needed was some way of using local resources appropriately, and best of all some way of using renewable resources to decrease the need for reliance on outside help. Wind, solar and biogas energy are possibilities, but another resource widely available and already in use for thousands of years is water. Water is attracting much attention in the search for renewable sources of energy. However, despite continuing public outrage at the devastating impact of large hydro-electric schemes on people's livelihoods and the environment [page 539 and Places 82], vast sums of money continue to be pumped into big dams and other inappropriate power generation plans. On the other hand, the intermediate approach, through small-scale hydro, has no negative impact on the environment, offers positive benefits to the local community, and uses local resources and skills.'

Practical Action

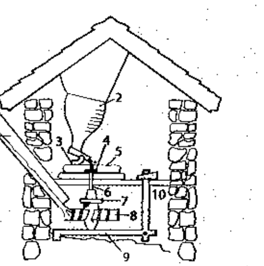
Practical Action and micro-hydro in Nepal

'The small Himalayan kingdom of Nepal ranks as one of the ten poorest countries in the world. Around 90 per cent of its 19 million people earn their living from farming, often at a subsistence level. The Himalaya mountains offer Nepal one vast resource – the thousands of streams which pour down from the mountains all year round. Nepali people have harnessed the power in these rivers for centuries, albeit on a small scale [Figure 18.27].

About 20 years ago, two local engineering workshops began to build small, steel, hydro-power schemes for remote villages. These turbines have the advantage of producing more power than the traditional mills, as well as being able to run a range of agricultural processing machines [Figure 18.28]. Practical Action first became involved in Nepal's micro-hydro sector in the late 1970s when the local manufacturers asked for help in using their micro-hydro schemes to generate electricity.

In the mid-1980s, Practical Action ran two training courses on micro-hydro power aimed at improving the technical ability of the nine new water turbine manufacturers that had been established in Nepal. These courses were very successful and prompted an agreement between Practical Action and the Agricultural Development Bank (the agency which funds micro-hydro power in Nepal) to collaborate on the development of small water turbines for rural areas. This work not only improved and extended the range and number of micro-hydro schemes in Nepal, but also established Practical Action as a leader in the field. In 1990 Practical Action was included in a government task force investigating the whole area of rural electrification; and in 1992 Practical Action was asked by the government to help establish an independent agency to promote all types of appropriate energy in rural areas of the country.'

Practical Action



1 chute delivering the water to the paddles of the wheel
2 grain hopper (basket)
3 device to keep the grain moving
4 metal piece to lock top of shaft in upper millstone
5 grinding stones
6 metal shaft
7 thick wooden hub
8 wooden horizontal wheel, with obliquely set paddles attached to hub
9 metal pin and bottom piece
10 lifting device to adjust gap between millstones

Figure 18.27

Cross-section of a traditional Nepali water mill

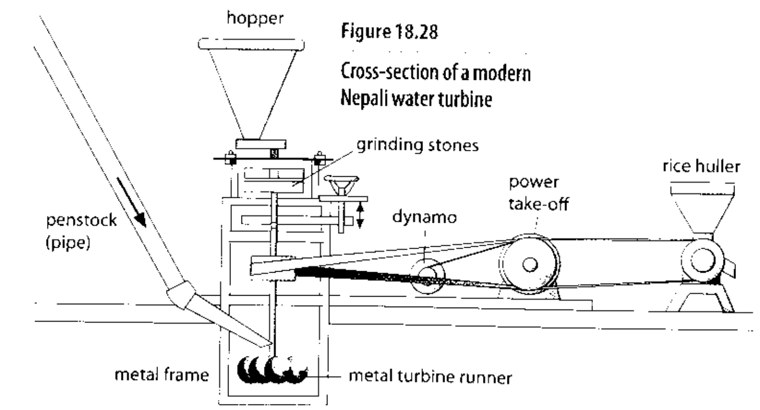


Figure 18.28

Cross-section of a modern Nepali water turbine