Geo Factsheet

Number 38

Environmental Implications of Renewable Energy

The huge advantage of renewable sources of energy is that they are based upon sources which will not run out. Unlike coal, oil and gas, which will certainly run out (and become much more expensive as they begin to run out), the sun, wind, waves and heat from the earth's core will never stop or run out. Theoretically, the use of renewables therefore potentially solves all of our energy requirement problems.

However, this is certainly not the case yet and there are serious technological and practical problems to be overcome before renewables can even begin to replace conventional sources, that is fossil fuels and nuclear. The major environmental argument for renewables is that they decrease our need to use fossil fuels and nuclear sources. All fossil fuels contain carbon, so burning them inevitably releases carbon dioxide - a major contributor to the enhanced greenhouse effect. Combustion of fossil fuels usually also releases sulphur dioxide and nitrogen dioxide, which are making the natural problem of acid rain much more serious.

The environmental problems of fossil fuels do not only stem from their combustion. Coal mines are important sources of air and water pollution, subsidence and dereliction. Oil extraction and transport pollutes the seabed, the sea and, through leakage or catastrophe, coastlines, habitats and wildlife.

The use of uranium in nuclear energy generation produces wastes which will remain lethally radioactive for centuries. Radioactive discharges to the atmosphere and to the oceans may also cause serious environmental harm. Thus, the use of renewables potentially reduces all of these environmental problems. However, it is worthwhile remembering that **all** forms of energy generation cause pollution. The manufacture of generating plant - whether it be a nuclear power plant or a wind farm - uses energy and raw materials, as does the maintenance of energy storage and transmission facilities. Renewable sources such as tidal and hydro-electric have huge ecological effects, as well as significant visual effects on the landscape. By altering estuarine or hydrological regimes, their environmental effects may radiate hundreds of miles away from their sites. Unfortunately, these problems are not as well understood as those caused by gaseous emissions. Thus, it is important to realise that renewable sources of energy may not be as environmentally benign as their supporters sometimes claim. Table 1 summarises the major forms of renewable energy. Table 2 (overleaf) summarises the environmental impact of renewable forms of energy.

Exam Hint *- Candidates far too often produce trite responses along the lines of 'Fossil fuels bad, renewables good.....'*

Table 1

Type	What it is
Solar energy	**Photothermal** energy generation involves using mirrors to concentrate the sun's rays onto water-filled black pipes. The water heats up to 50-60°C and can be used for domestic heating. In **passive solar energy**, use is made, for example, of large, south-facing windows (in buildings in the northern hemisphere) to catch maximum sunlight and very small or non-existent northern-facing windows. **Photovoltaic** generation involves using photovoltaic cells which convert solar energy into electricity using, for example, silicon cells.
Wave power	The kinetic energy of waves is converted, by floating devices such as Salter's ducks into electrical energy which is then stored in a battery.
Tidal power	Tides are trapped within a man-made barrage, usually across an estuary. The barrage contains sluice gates which can be opened to allow the incoming tide in and then closed to prevent the tide running out. When water is released through the sluice gates, it turns turbines which generate electricity. The energy that is generated is proportional to the difference in height of the water on either side of the barrage.
Ocean thermal energy conversion (OTEC)	Within 30° latitude of the equator, the surface temperature of the ocean is about 20°C warmer than the lower waters. OTEC uses this temperature gradient. The heat of the surface water is used to evaporate low-boiling point liquids, eg. ammonia. This produces a vapour which, under pressure, is used to turn turbines to generate electricity. The vapour is then transferred to cooler, deeper waters where it condenses before being pumped back to the surface.
Hydro-electric	Water is stored in high-altitude lakes or dams. When required, the water is allowed to run downstream, gaining velocity before passing through turbines, generating electricity. The water is then stored in a lower lake or reservoir before being pumped back up to the top lake.
Wind	Windmills are essentially turbines which, when turning, convert kinetic energy into electrical energy. The energy generated is proportional to wind velocity.
Geothermal	The rocks in the earth's core contain minerals such as uranium which are radioactively decaying. This heats the rocks which can then be used to heat water. This super-heated water can then either be used directly - eg. to heat buildings - or to produce steam which is passed through turbines to generate electricity. In Iceland, water is pumped through hot lava to generate the hot water.
Biofuels (biomass and biogas)	Biofuels are crops or organic matter such as agricultural wastes which can be used as fuels. They are defined as renewable because they are based upon plants which have trapped the sun's energy during photosynthesis and converted it into chemical energy. Biogas (a mixture of carbon dioxide and methane) is generated when organic matter decays. The gas can be collected and burned, for example, to heat water for heating buildings.

Table 2

Type	Environmental Implications
Solar energy	This is potentially very important, since typical households use 60% of their total energy requirements in space-heating or heating water. The main environmental implication of passive solar, photothermal and photovoltaic systems is through their visual impact. Photovoltaic cells use silicon which is unlikely to run out since it is the most abundant element in the earth's crust. Photovoltaic cells are silent, have no moving parts and have very low operating and maintenance costs.
Wave power	Lines of Salter's ducks or their equivalent may detract from the visual beauty of the coastline.
Tidal power	Construction of estuarine barriers has major environmental effects: (i) Behind the barrier, the level of water at low tide will be permanently higher than it was before construction of the barrage. Flooding of mudflats will decrease feeding and breeding grounds for resident and migratory birds. Flooding will decrease salinity and change the species composition of these habitats. (ii) Decreased tidal amplitude means that wave action is concentrated on a smaller area of shore, where erosion rates may increase. Lower wave velocities will decrease erosion elsewhere but decreased velocity will lead to increased deposition which may influence navigation channels. Increased siltation will decrease the number of invertebrate populations which could have a knock-on effect on bird populations. (iii) Flushing times - the period needed for a body of water to move out of the estuary - will increase, thus any pollutants entering the estuary will remain there longer. (iv) The barrier will act as a physical barrier to fish movements to spawning grounds etc. (v) Increased deposition of sediment (because of decreased velocity) will decrease turbidity (cloudiness) of water which will increase light penetration and the oxidation of pollutants. The rate of photosynthesis may also increase although this may lead to algal blooms. Overall, biological productivity is likely to increase.
Ocean thermal energy conversion (OTEC)	Few environmental implications unless CFCs are used as vapours.
Hydro-electric	The "head" of water is usually produced by building dams. Dams: (i) May decrease flooding downstream (ii) Provide year-round water for irrigation (iii) Allow large bodies of stationary water to heat up which increases the growth of algae and micro-organisms which can lead to siltation or health problems. (iv) Effectively deprive downstream areas of silt, thus reducing their fertility. (v) Decrease sediment load of downstream rivers which may lead to an increase in their velocity and erosivity. (vi) May mean huge areas of land are flooded, destroying valuable habitats and necessitating large-scale relocation of people, villages, etc. (vii) May attract tourists and hence improve the economy of the area.
Wind	The noise from the blades and the size, arrangement, number and colour of windmills may detract from the landscape beauty of an area. Most windfarms are in the uplands which are often in National Parks - areas which are specifically designated for their high landscape beauty.
Geothermal	Very few environmental impacts. In the UK, hot aquifers could provide heating water in several areas.
Biofuels (biomass and biogas)	Although burning the biofuel releases carbon dioxide, it is argued that this is equalled by the carbon dioxide which the plants have absorbed during photosynthesis, hence the net effect on atmospheric carbon dioxide concentrations is zero. Energy crops can be grown on otherwise marginal land and improve local habitats and soils. They can also be used on surplus agricultural land and provide farmers with a means of diversification. However, monoculture plantations of, for example, willows may need fertilisers and pesticides and may look visually unattractive.

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