

Water power has already played an important role in the past and is a significant source in present worldwide energy supply. As an energy resource it can be divided into three main areas: hydroelectricity, tidal power, and wave power. Although the use of these resources to generate electricity emits no carbon dioxide emissions, they can often have a direct negative impact ecologically and socially. These issues need to be addressed and resolved before wider use of water power can really be considered sustainable and form part of a future energy strategy.

Water is the source...

Around 70% of the Earth's surface is covered with water. There are different ways in which water can be used as a source of energy and humans have been exploiting this power for many centuries. Early waterwheels were driven by the flow in rivers or tides and used to grind cereals in mills, or to drive industrial machinery. The use of water as a source of energy has continued to develop, and can be categorised into three main areas; hydroelectricity, tidal, and wave.

Did you know...?

Before the advent of steam power, waterwheels were one of the main sources of power, and so industry and villages were often based near a river.

Hydroelectricity

Hydroelectricity is the extraction and conversion of energy from water into its most useful form; electricity. Where water flows from a high level to a low level, turbines are used to capture the energy in this flow to drive a generator to produce electricity.

This can be done in two main ways. The first simply uses the direct flow of water in a river and extracts energy according to how high or low the flow is. The second dams the river to capture and store the water until it is needed. When it is needed a water gate on the upper side of the dam opens, letting water surge through a tunnel leading to turbines and generators.

The use of a dam to store the water is more controllable and reliable, not dependent on the high or low flow of the river. Hydroelectric schemes are well established and provide around 20% of the world's electricity, predominantly from largescale projects involving the use of dams. Although hydroelectricity does not produce any carbon dioxide (CO_2) emissions, there are associated environmental and social impacts with the creation of the dams and reservoirs needed for large scale schemes. Dams have an obvious visual impact, and the flooding of the river valley into a reservoir results in loss of habitat for the area's flora and fauna, and if villages or towns exist they and their people must be removed.

There are also questions over the safety of large hydroelectric schemes. The chances of a major disaster involving significant loss of life have been calculated at the same level as nuclear accidents. So, despite there being lots of potential for more large-scale installations, opposition to their negative effects has halted some new developments. Smaller scale schemes using rivers and streams, which avoid the need for a dam and reservoir, are safer, have very little impact on the environment, and are increasingly being looked at.



Above: How a large scale hydroelectric scheme works

In the forested hills of south-east China smallscale hydroelectricity schemes provide power at the village level where areas are too remote to be supplied by national electricity distribution systems. These schemes have much benefit to local populations whilst at the same time have very little negative environmental impact. In contrast, China is currently embarking on the largest and most controversial hydroelectric power scheme in

the world, The Three Gorges Dam, due for completion in 2009. When completed it will supply the Central and Eastern China electric distribution system with 18 million kW of cheap and clean electricity, which would otherwise be supplied by burning coal, the worst emitter of CO_2 emissions. However, the resulting reservoir behind the 185 metre-high, 1.2 mile-wide dam will be 410 mileslong, flooding millions of hectares of cropland, historic sites, wildlife habitats, and forcing over 1 million people to leave their homes and be resited.

Tidal power

The gravitational forces between the Earth and the Moon cause them to rotate around one another in a 28-day cycle (a lunar month). These forces also result in a tidal 'swell' in the sea facing the moon, and another on the opposite side of the Earth. Similar, but smaller, tidal swells are caused by the gravitational attraction between the Sun and the Earth. A large amount of energy is stored in tides, as they go in and out we can capture this energy with tidal power stations.



Above: How a tidal barrage scheme works

The most widely used method to harness tidal energy is to dam the estuary using a 'tidal barrage' and use turbines linked to a generator to produce electricity (very similar to hydroelectricity schemes except that the flow of the water is much more predictable and reliable). When high tide comes in, water flows through the turbines and ends up on the other side of the barrage where it is captured by a lowered gate. When low tide comes, the gate is raised and the water flows out, again through the turbines, to generate more electricity. Environmentally, tidal schemes do not emit CO_2 but they do impact upon the local area. They have a visual impact, and usually raise the water level behind the barrage by half a metre or so, which in turn can have drastic implications on local wildlife, for example flooding marshland where birds nest. They may also influence the build up of silt and sediment in the barrage basin. Tidal power stations are already being used in Canada, France, Russia and China.

By far the largest tidal power station in the world, and the only significant one in Europe, is at La Rance in France. The main reasons why more tidal schemes are not being developed is that they are very expensive to build and they often create electricity when it isn't needed as much. An alternative to tidal barrages are tidal flow turbines (similar in appearance to wind turbines).

Wave Power

When wind hits water it transfers a lot of its energy, creating the motion in the water we call waves. Wave energy research has been taking place for about 25 years and a variety of designs have been proposed and tested but the technology is not yet fully developed. The UK wave energy resource is amongst the largest in the world because it is situated on the north-east corner of the Atlantic, where it receives waves which have been generated across the several thousand miles of ocean. There is an onshore wave energy generator on the west coast of Scotland.

Will water power be the way of the future?

The combined potential energy resource from all three water power options could make an extremely large contribution to a future sustainable energy supply, substantially reducing the need for polluting fossil fuels. However, there are other environmental and social impacts that need to be taken into account, especially where a scheme is particularly large.

Sponsors: The National Energy Foundation, The Department of the Environment Transport and the Regions, Student Force, PowerGen

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